DOCUMENT RESUME

ED 258 838 SE 045 836

AUTHOR	Lopez, Gil; Araŕson, Joel B.
TITLE	Promoting Success through Collaborative Ventures in Precollege Science and Mathematics.
INSTITUTION	National Association of Precollege Directors, New York, NY.
SPONS AGENCY	Alfred P. Sloan Foundation, New York, N.Y.; National Action Council for Minorities in Engineering, Inc., New York, NY.
PUB DATE	85
NOTE	67p.; Photographs will not reproduce well.
AVAILABLE FROM	National Association of Precollege Directors, c/o National Council for Minorities in Engineering, Inc., 3 West 35th Street, New York, NY 10001 ($5.00 per copy, plus $2.50 postage, $4.50 each for 2-9 copies plus $2.50 postage.)
PUB TYPE	Reports - Descriptive (141)
EDRS PRICE	MF01/PC03 Plus Postage.
DESCRIPTORS	Academic Achievement; Career Planning; College School Cooperation; *Cooperative Programs; *Engineering Education; Industry; Information Networks; *Mathematics Education; *Minority Groups; Models; *Program Descriptions; School Business Relationship; *Science Education; Science Programs; Secondary Education; Technology

ABSTRACT

This publication presents a synthesis of the efforts made over a decade to increase minority participation in precollege engineering studies. It is produced by the National Association of Precollege Directors (NAPD), a coalition of 19 program specialists which serves as a central base for program networking and the sharing of ideas and information that promote academic success in students. These programs serve to increase student scholastic achievement in all subject areas, especially mathematics and science, and to heighten student awareness of careers in engineering, science, and technology. Functioning as educational extensions to participating schools, they involve industry and higher education facilities in program activities. Tutorial services are also provided and detailed records that continually monitor academic performance are maintained throughout the students' high school years. The report describes various NAPD programs, presents a brief history of the precollege minority engineering effort and identifies common elements of the different program models. Generalized program results are summarized in tabular form. Appendices include: (1) program summaries; (2) a list of NAPD members; (3) bibliographic references; and (4) a list of NAPD program sponsors. (ML)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

SE

PROMOTING SUCCESS

THROUGH COLLABORATIVE VENTURES IN PRECOLLEGE SCIENCE AND MATHEMATICS

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY
National Action Council for Minorities in Engineering, Inc.
TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

U.S. DEPARTMENT OF EDUCATION
NATIONAL INSTITUTE OF EDUCATION
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

✓ This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official NIE position or policy.

ED258838

SE 045 836

NAPD

National Association of
Precollege Directors

PROMOTING SUCCESS THROUGH COLLABORATIVE VENTURES IN PRECOLLEGE SCIENCE AND MATHEMATICS is a product of the National Association of Precollege Directors (NAPD), a coalition of nineteen precollege program directors whose mission and program efforts are directed at increasing the pool of minority students who pursue engineering and math based college study. Funding for the document was made possible through a grant from the Alfred P. Sloan Foundation supplemented with funds from the National Action Council for Minorities in Engineering (NACME).

TO ALL OUR STUDENTS WHO STRIVE FOR EXCELLENCE, LABOR IN THEIR STUDIES AND SHARE THEIR GIFTS OF LEARNING WITH OTHERS.

MICROFILMED FROM
BEST AVAILABLE COPY

Copyright © 1985 by the National Association of Precollege Directors

No part of this document may be reproduced by any mechanical, photographic, or electronic process, or in the form of a phonographic recording, nor may it be stored in a retrieval system, transmitted, or otherwise copied for public or private use without written permission from the National Association of Precollege Directors (NAPD), c/o NACME 3 West 35 Street, New York, N.Y. 10001

TABLE OF CONTENTS

Preface 4
Introduction 5
Common Elements of NAPD Programs 7
The Precollege Venture 11
The Record—Impact on Students 14
The Third Party Model 20
Models of Organization 21
Learning from Experience: Common Elements which Promote Success 25
Program Structure 26
Program Functions: Teachers 29
Program Functions: Students 30
Motivational Activities 33
Conclusion 35

Appendix A – Program Summaries 37
Appendix B – NAPD Members 53
Appendix C – Selected Bibliography 55
Appendix D – Sponsors of NAPD Programs 59

PREFACE

PROMOTING SUCCESS is the description of an evolutionary process by which a diverse set of programs reached a common set of themes. Behind this process is a story of support and commitment which many view as unparalleled in the annals of American philanthropic ventures.

This publication has two purposes: to offer our friends, contributors, and advocates a global view of what has resulted from a decade of work at the precollege level to increase the pool of minority students who pursue engineering studies; and to make available to those who are concerned with the many problems of precollege science and mathematics the product of our positive experience in combatting most of those same problems in a slightly different context.

We wish to acknowledge the assistance of many individuals and organizations, among them:

The Alfred P. Sloan Foundation whose early studies gave impetus to precollege programs and whose funding not only gave birth to several programs but enabled the directors to come together, support, and learn from one another.

The hundreds of corporations that made the continuation of these programs possible for over a decade and through their generous support of NACME helped enable our collaborative efforts.

Joel B. Aronson and Gil Lopez who served as the primary writers of this document. Gil worked with the NAPD executive committee to develop a conceptual framework and format for the document. Joel visited programs and conducted interviews with students, teachers, administrators, and others to give a first-hand view of the programs, what they share in common, and why they work.

The directors and former directors who helped create the programs, had the perseverance to make them work, and by sharing their years of experiences made this publication possible.

Carolyn C. Chesnutt, Chair
National Association of
Precollege Directors

INTRODUCTION

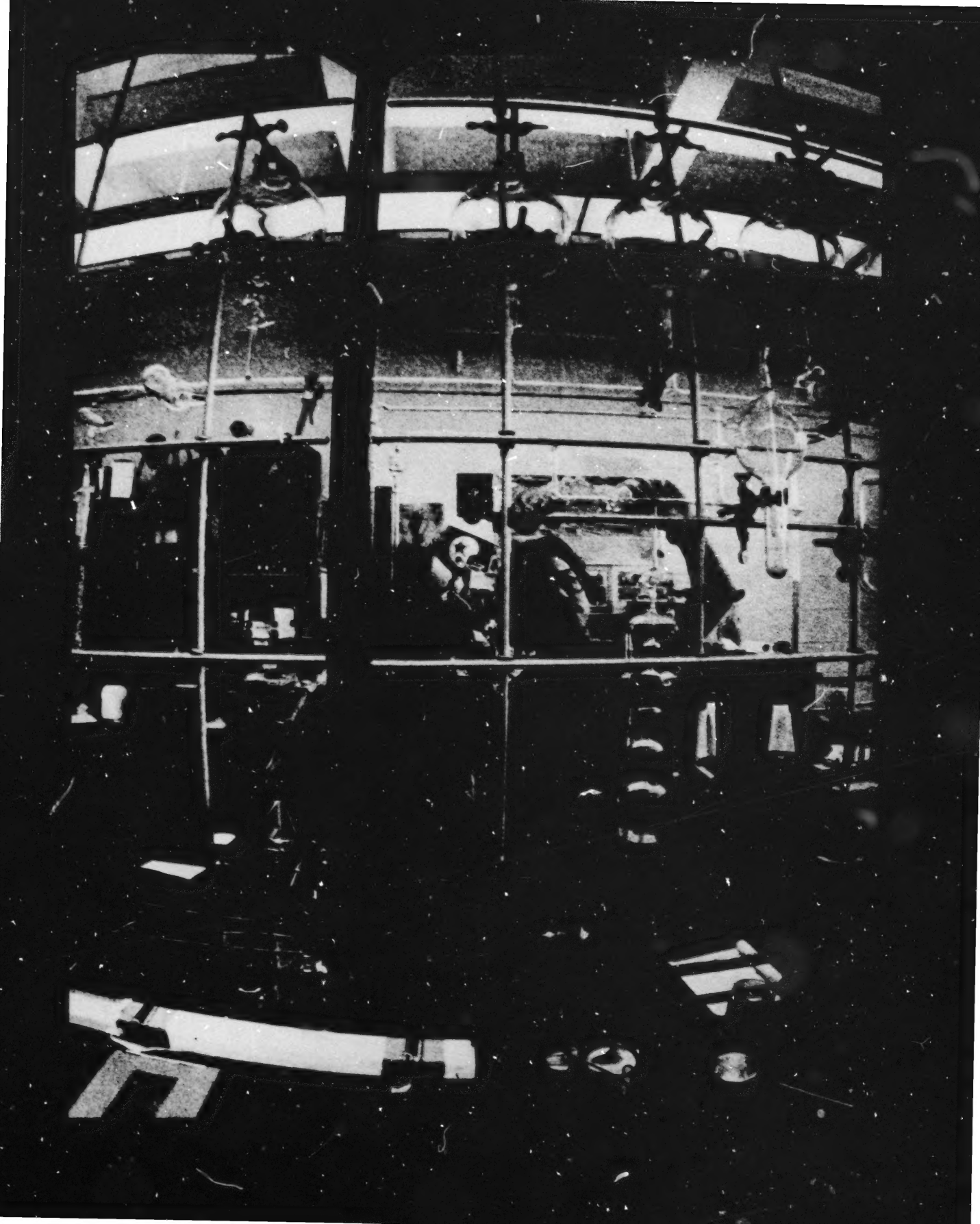
In 1983, the President's Commission on Excellence in Education, the National Science Board, and the Carnegie Foundation for the Advancement of Teaching all issued reports that focused on precollege science and mathematics. The reports challenged those concerned with high quality education to find ways to attract and prepare larger numbers of students for careers in science and engineering because the nation may not have enough people in the technical professions in the 1990's and beyond. A decade earlier, a similar challenge was faced—finding ways to attract and prepare minority students for engineering studies and careers in engineering where they were severely underrepresented.* In response to that challenge, senior executives from industry, working together with leaders from engineering colleges and local school systems, embarked on an action plan in 1973 which led to the development of a group of precollege programs that now enhance the study of mathematics and science in hundreds of secondary schools across the country.

THE CENTRAL PURPOSE OF THESE PROGRAMS IS TO BRING STUDENTS TO MATH AND SCIENCE STUDY WHO WOULD NOT OTHERWISE BE THERE.

The question of why greater numbers of students do not follow academic paths which lead to technical careers is as pertinent today as it was in 1973. A major part of the problem is that students are often left to make important academic selections by themselves and do so many times with information which is insufficient to make those choices wisely. Short term rather than long term goals are pursued and the paths of least resistance are easily taken. Before they can understand and feel the impact of the consequences, many students drop Algebra for General Mathematics and opt for General Science and commercial courses over Biology, Chemistry and Physics. By making such choices, large numbers of students close the door to a wide array of potential careers, and that door stays closed unless they receive positive outside guidance and support.

The principal quality of the precollege programs described in this document is their capacity to create intervention and support systems that promote success in students. United by a common philosophy and set of goals, nineteen precollege programs founded over the last twelve years are now member organizations of the National Association of

*The four ethnic minority groups underrepresented in engineering were Black, Mexican American, American Indian and Puerto Rican.



Precollege Directors (NAPD) which serves as a central base for program networking and the sharing of ideas and information. NAPD programs operate across a wide range of school demographics and community environments. Though their approaches may differ, their basic mission is the same:

- To increase student academic achievement in all subject areas, especially mathematics and science, and
- To heighten student awareness of careers in engineering, science and technology.

Utilizing a systems approach to identify and nurture student academic potential, NAPD programs bring a spectrum of resources to local school systems that augment and enrich the process of education at the precollege level. Functioning as educational extensions to participating schools, they tap elements of the outside world of industry and higher education to help students see how the study of mathematics and science is related to the practices of engineering and technology.

ALTHOUGH THE PROGRAMS HAVE COME TO THEIR PRESENT STATES FROM DIFFERENT DIRECTIONS, A SHARED PHILOSOPHY HAS CREATED A LARGE NUMBER OF COMMON ELEMENTS WHICH FORM THE FOUNDATION FOR PROGRAM SUCCESS.

Common Elements of NAPD Programs

The process of NAPD intervention is long term. Once started in the lower high school grades it continues uninterrupted throughout the students' high school years. NAPD programs work closely with students to ensure their enrollment and achievement in the subject areas prerequisite to engineering college study. Mathematics and science curricula are supplemented with engineering applications, guidance and tutorial services are provided and detailed records that continually monitor student academic performance are maintained. The close ties and attention given students bring about a realization and purpose of study and upon graduation students enter college with the necessary academic preparation and confidence to succeed.

What NAPD programs do in their cooperative relationships with schools is viewed by parents, teachers and educational administrators as very beneficial and positive for both students and schools. Not only are NAPD programs effective in promoting success in students, they also provide schools with an interactive link through which relationships with a host of institutions and agencies can be formed and maintained at minimal cost.

An NAPD presence at a school stimulates the develop-

ment of special programs that bring meaning and significance to mathematics and science study. In this capacity NAPD programs function to provide resources to revitalize the mathematics and science curricula with real world applications which help teachers and students keep up to date with advances in science and technology.

NAPD programs promote success in students through a process which is at first catalytic and then resourceful, leading to a system of instruction and learning where students and teachers work together to effect high student academic performance. The NAPD programs and the work in which they are engaged with students and schools are collaborative in nature and are unique in these important ways:

- They have been funded almost exclusively by the private sector for more than a decade.
- They are grassroots efforts initiated by people who have a personal and professional stake in improving education at the local level.
- They are a collaboration among local business, the university, and the school system, bringing expertise and resources to participant schools to supplement what is already available.
- They are sustained efforts; both students and teachers can count on program continuation from year to year.

In addition:

- Program interaction with students begins early (usually at the eighth or ninth grade level but sometimes earlier) and continues throughout students' high school tenure, and beyond if possible.
- Program costs are low. The programs work within the school administrative structure and make maximum use of volunteers as well as professionals on sabbatical leave from industry and college. Yearly costs per student vary from $35 to $200 depending on location and program.
- Many of the recommendations and suggestions in the 1983 reports—"Master-Teachers", "Adopt-a-School" programs with industry, summer enrichment and expanded time-on-task, to name just a few—are employed by NAPD programs as part of their school intervention strategies.

Though the efforts and work of NAPD programs have been directed towards engineering and the students who benefit are underrepresented minorities, there is nothing inherent in the model approach which limits the system to minorities or engineering. On the contrary, the objective of NAPD programs has always been to provide each student with a strong academic foundation and a sense of confidence and determination that can be utilized to successfully pursue college study.

This NAPD document is meant to describe the programs, not to assess or critique them. Formal review is not yet possible because of the progressive and developing nature of the effort and because comprehensive data are not yet available on a national basis. In the interim, all those involved with the programs agree that much progress has been made and that students, teachers and schools alike have benefited. Teachers' attitudes are very positive, their level of enthusiasm is high and they routinely volunteer to participate in the often demanding nature of NAPD program activities. Student interest and achievement have resulted in larger mathematics and science classes and more upper-level courses being offered. Students' SAT performance has improved. High schools report higher rates of college acceptance among their graduates, and greater numbers of students have chosen engineering and other math-based courses of study in college. In addition to these indicators of progress, NAPD programs have been independently judged time after time by corporate contributors, national foundations, state legislatures, and participating school systems. This scrutiny has repeatedly yielded increased program involvement and steady expansion.

What follows is a brief history of the precollege minority engineering effort, how NAPD programs evolved over the years, the qualities that make them unique models of school intervention, what they have in common and general description of the programs themselves.

THE PRECOLLEGE VENTURE

The precollege programs which are the focus of this publication have their roots in a meeting in July of 1972, when General Electric hosted an Engineering Education Conference in Crotonville, New York devoted to discussion of the scarcity of minorities in the engineering professions. Further impetus came about a year later at a symposium on Increasing Minority Participation in Engineering convened by the National Academy of Engineering in Washington, D.C. This three-day event was attended by senior executives from two dozen major industrial companies, staff members from numerous colleges (forty of which were Deans of Engineering or Assistant Deans), and by representatives from federal government agencies, engineering societies, public schools, and a variety of other organizations with similar concerns for science and engineering education.

The problem these meetings addressed was twofold. A large segment of American society was not actively participating in the rapidly expanding technological world, and industry was not getting its full share of bright minority people or their ideas. Senior management at major industrial corporations knew that engineering was the most common pathway into management and there were not many minority engineering students and still fewer minority engineers. In 1972, Blacks, Hispanics, and American Indians constituted about 3% of the student body at engineering schools and less than 1% of the engineering profession. The reasons for this underrepresentation were complex, but several industrial leaders felt that a sustained, coordinated, well-supported effort based on a thorough analysis of the problem could help remedy the situation. The Alfred P. Sloan Foundation contributed to this goal by funding a planning commission and publishing in 1974 a summary report entitled "Minorities in Engineering: A Blueprint for Action." Because of its careful documentation of the problems and its action-oriented suggestions, this report quickly became the "Bible" in the effort to increase minority participation in engineering.

As a direct result of the National Academy meeting, several organizations were established to enlist broad industrial support, provide scholarship funds to minority engineering students, and coordinate the many activities which were beginning around the country. Ultimately, the National Action Council for Minorities in Engineering (NACME)

IN 1972, BLACKS, HISPANICS, AND AMERICAN INDIANS CONSTITUTED ABOUT 3% OF THE STUDENT BODY AT ENGINEERING SCHOOLS AND LESS THAN 1% OF THE ENGINEERING PROFESSION.

was organized to lead the national effort. Under the leadership of chief executive officers from companies like Dupont, Exxon, Honeywell, IBM, and Bethlehem Steel, NACME has provided scholarship funds for minority engineering students, given technical assistance to emerging precollege and college level programs and served as a clearinghouse for information on minorities in engineering programs.

Originally, the major focus was at the college level. It was thought that if engineering were promoted more widely among minority students and if financial support were made more available, the field would attract students in significant numbers. However, early experience and further analysis (Alfred P. Sloan Foundation, 1975) suggested that a far more active precollege effort was necessary if minority participation in engineering was to be increased. Most students simply were not electing the mathematics and science courses in high school which would prepare them for college science and engineering study.

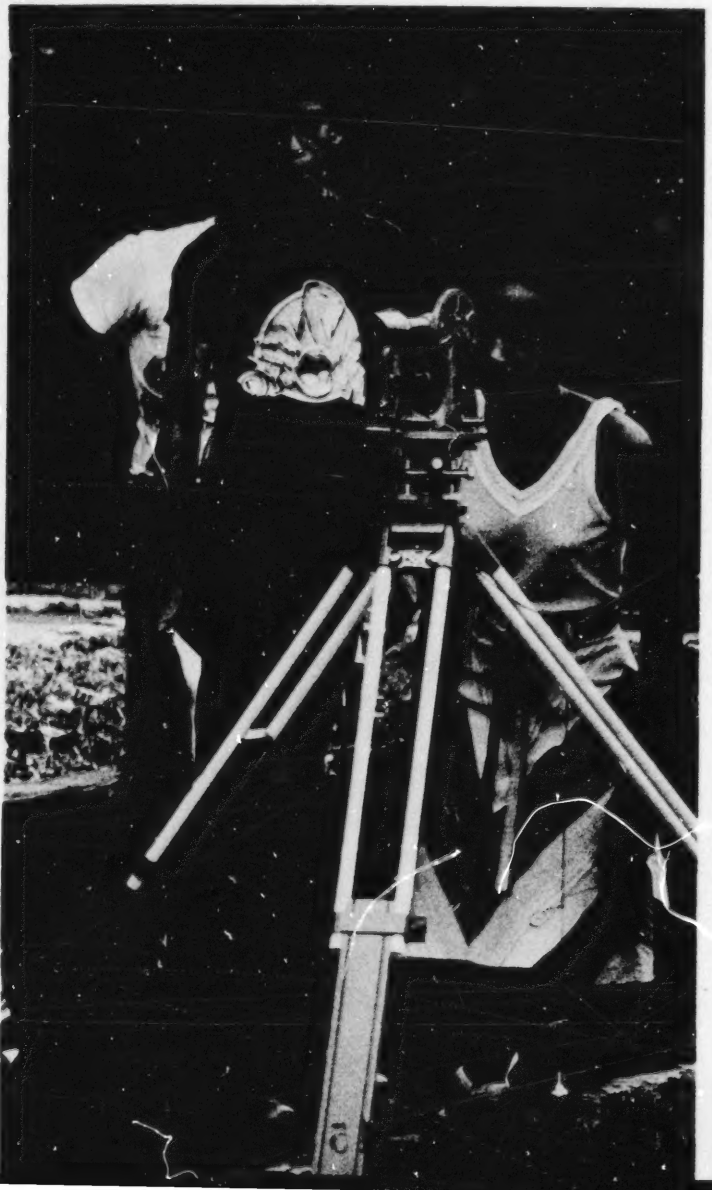
The Sloan Foundation reiterated its concern by making several multi-year grants to local and regional consortia which could serve large numbers of minority youth at the precollege level. As the programs grew and others started, a group of directors developed an informal network as they sought advice from one another.

Finally, in 1978—again with Sloan Foundation assistance—the National Association of Precollege Directors (NAPD) was formed. Its purposes were to analyze common problems and opportunities, review program operations, share insights and successful techniques, and interact with other groups interested in similar objectives. Today, programs represented by NAPD have years of experience engaging in activities which have cut across geography, ethnicity, and specific education structures in order to better serve schools and students.

It is thirteen years since the Crotonville conference, and the initial group of corporate organizers* is still investing in these programs. They have been joined by more than 200 nationally known companies, as well as scores of others active in regional and local markets. In addition to millions of dollars contributed for operating funds, they lend personnel and provide equipment and expertise to local, state and regional programs in all parts of the country.

*ALCOA, AT&T, Bechtel, Dupont, EXXON, General Electric, General Motors, IBM, McDonnell Douglas, Olin Corporation, RCA, Union Carbide, United States Steel, Westinghouse, and Xerox.

In return, the companies have gained immediate visibility as educational partners in local school systems. More importantly, they will also gain the considerable contributions of hundreds of new employees who will be able to enter technical careers because of the programs these companies have supported.



TODAY, PROGRAMS REPRESENTED BY NAPD HAVE YEARS OF EXPERIENCE ENGAGING IN ACTIVITIES WHICH HAVE CUT ACROSS GEOGRAPHY, ETHNICITY, AND SPECIFIC EDUCATION STRUCTURES IN ORDER TO SERVE SCHOOLS AND STUDENTS.

THE RECORD— IMPACT ON THE STUDENTS

Of the nineteen comprehensive precollege programs which are part of NAPD, several have many years of experience and offer a mix of services and support, while others have been recently established and are still in the process of evolving. Indeed, for several, the first product of their efforts—high school seniors accepted by universities for technical study—is still before them.

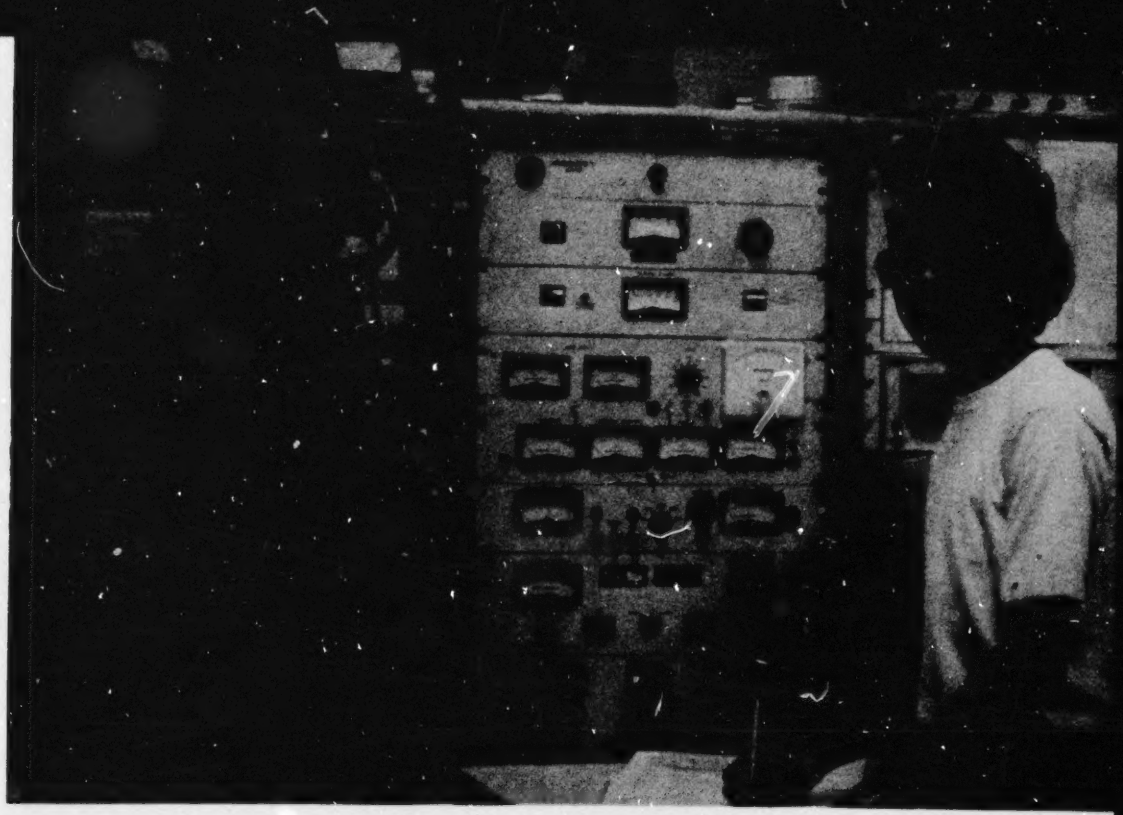
ACROSS PROGRAMS, MORE THAN 80% OF THE PARTICIPANTS GO ON TO A FOUR-YEAR COLLEGE, AND NEARLY THREE FOURTHS OF THOSE CHOOSE TO STUDY ENGINEERING OR OTHER MATH-BASED FIELDS.

Even the oldest programs are just beginning to see the ultimate results of their labors—students with baccalaureate degrees in engineering and other related fields. The early years were a time of development when the number of students involved was small. Now, however, there are thousands of students currently in college studying engineering and other technical subjects and many more thousands in NAPD programs in high schools heading in the same direction. (See Table I.) Across programs, more than 80% of the participants go on to a four-year college and nearly three fourths of those choose to study engineering or other math-based fields (Chart I).

Student motivation is far too complex to claim a clear cause and effect relationship between the influences of these programs and student success in a college-level engineering degree program. However, the extensive records kept by each program and the interim goals they have achieved make a strong case for their positive impact.

Scores of students from various programs have been interviewed. They tell of becoming involved for one of three primary reasons:

- They had a well-developed interest in science and mathematics and saw the program as a pathway to their career goals.
- They were not especially interested in a math-based career field, but saw the program as supportive, rigorous, and demanding, and wanted to be part of it to get the best out of themselves.
- They were able students with no specific goal orientation who were urged to participate by teachers, parents, older brothers and sisters, friends, or counselors.



Program impact is hardest to assess for the students who are in the first of these categories because many of the driving forces are already present when they begin to participate. For these students, the most likely effect of the programs is to help sustain their interest in becoming engineers and scientists. Students in this group are especially important because their strong motivation makes them likely to succeed in university level studies.

Students who participate without any special interest in engineering certainly form the smallest group, but the impact of the programs upon them is still important. Some are intrigued by the challenge of a technical career as they learn more about those options. Others never enter a math-based profession but emerge with a solid mathematics and science foundation to their education which will improve their understanding of the technical aspects of whatever field they do enter. Though these students may not be counted as successful products of the programs, their own careers will be enriched by their involvement.*

*A 1981 National Research Council study "Science for Non-Specialists; The College Years" found that practitioners felt a good grounding in science and mathematics was important to potential leadership in fields as diverse as politics, journalism, law, business, religion and education.

It is the students from the third group who are the most crucial. While the obviously capable student is always welcome, the NAPD programs do not merely recruit engineering candidates from among the already likely. The central purpose of these programs is to bring students to math and science study who would not otherwise be there. Their goal is to substantially increase the pool of students with the pre-college credentials needed to enter engineering study and other technical areas. The third group includes large numbers of able students whose chance of going to any four-year college is small due to family financial circumstances, lack of role models among family and friends, fear of failure at rigorous course work, indifference, or poor counseling. The programs seek out these students and many of the program services are directed specifically toward them and their families. The programs' experience with these students show that most get caught up in the adventure; they become enthusiastic about science and mathematics, and many go on to study at first rate universities. This group of students provides a large number of engineering and science candidates who would not otherwise emerge from high school without program intervention in the normal process of education.

STUDENTS FROM NAPD PROGRAMS TALK ABOUT FEELING BETTER ABOUT THEMSELVES AS THEY SUCCEED AT LEARNING, ESPECIALLY WHEN THE COMPETITIVE SUBJECTS OF SCIENCE AND MATHEMATICS ARE INVOLVED. THEY DESCRIBE AN INCREASE IN SELF-CONFIDENCE FROM KNOWING THAT THEY HAVE LEARNED A RIGOROUS BODY OF KNOWLEDGE.

Data from the California/MESA program provides some support for the impressionistic conclusions from the student interviews. MESA now has 4,000 graduates, more than 85% of whom have gone on to four-year colleges and universities. Of this group, half have come from families which never before included a college graduate. This is a far higher proportion of first-time college students than among college freshmen nationally. Other data compiled by the State of California show that of the minority students in California who continue their education past high school, 85% attend two-year community colleges from which less than 5% transfer to a four-year institution. In constrast, among MESA students from comparable backgrounds, 85% go directly to four-year colleges and universities.

Beyond these head counts are changes in students, teachers and the process of education which cannot be quantified. These changes include shifts in attitude and perception which are both caused by and lead to more productive teaching and learning.

Students from NAPD programs talk about feeling better about themselves as they succeed at learning, especially when the challenging subjects of science and mathematics

are involved. They describe an increase in self-confidence from knowing that they have mastered a rigorous body of knowledge.

Within the next three years, large numbers of former NAPD students will be emerging from colleges and embarking on technical careers. There is ample reason to believe that many of them would not be there except for the influence of the NAPD precollege programs.

Changes in teachers' attitudes also reflect positively on the students. Teachers enjoy working with students who are highly motivated to learn. They enjoy being able to teach more advanced courses (physics, trigonometry, and calculus) as student interest increases. They are pleased with the access they have to engineering faculty, industry professionals, and the world outside the classroom. Many say that their classroom effectiveness is improved by their more complete understanding of the relationships between precollege education, industry and the university.

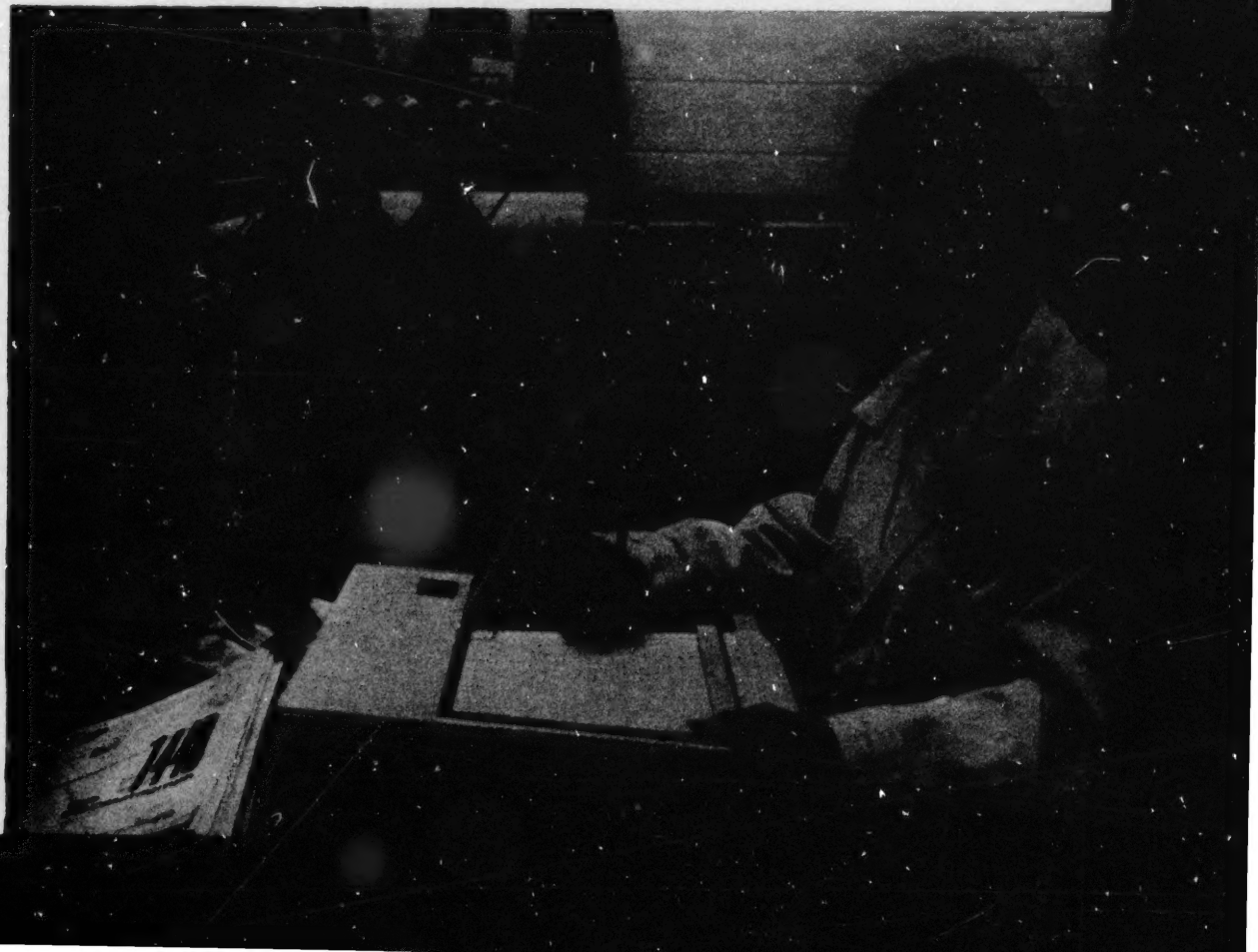


Table I. NAPD Program Summary Data

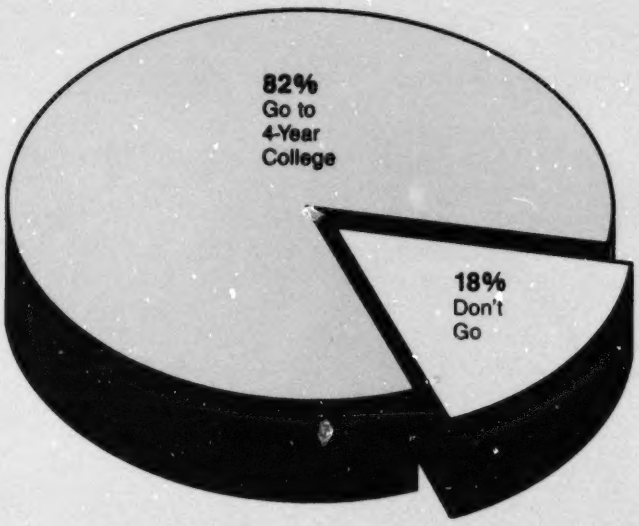
	1984 Precollege Participation		Year of First H.S. Graduates	High School Graduates Since Inception
	Students [a]	Schools		
BEAM	320	11	1983	33
CMEA	820	53	1983	84
CMSP	2,550	11	1975	1,650
DAPCEP	1,300	22	1981	503
FAME	250	b	1978	150
GEST	50	6	1977	150
IIT	450	b	1974	5,014
LEAP	238	8	1982	128
MASSPEP	300	6	1982	90
MESA/Cal.	3,820	138	1977	4,400
MESA/N.Mex.	310	10	1984	5
MESA/Wash.	2,200	11	1985	
METCON	981	13	1982	84
PRIME	1,866	33	1976	1,695
PRIS²M	603	6	1980	257
SECME	9,211	160	1979	6,216
TAME	15,000	120	1979	4,000
UCMEP	500	4	1984	45

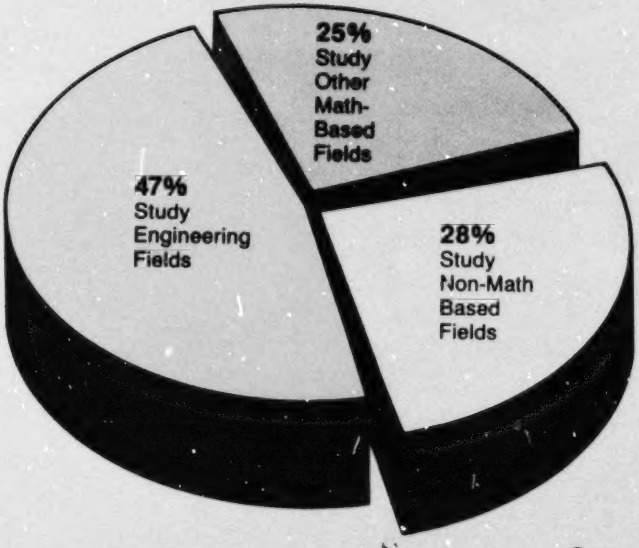
NOTES:

a. These figures represent only minority students who are full program participants. There are many additional minority and non-minority students who benefit from individual program elements but are not regular participants.

b. FAME and IIT both bring students from the schools to a central location for program activities.

Chart I. Education Plans of NAPD Students.





THE THIRD PARTY MODEL

The precollege programs of NAPD differ in critical ways from other attempts to improve education. The most significant departure is that these programs come to the school from outside, adding unique resources to what the school has already. It is this "third party" model that has facilitated the delivery of the assistance students need for success in precollege science and mathematics. Each program operates through a small staff which is not from industry, but is guided by it; frequently is university-based, but is not part of the university administration; works closely with the schools and the school board, but is not interwoven with the public school structure. Because of their position outside these organizations, program staff can deal with senior personnel without having to go through hierarchical channels. They can cut through red tape to solve problems quickly and directly and they can act unilaterally, if necessary, under conditions of urgency. Program staff can elicit ideas from all sources, use the combined strengths of its constituencies to resolve problems, and act as a broker to bring resources to meet the needs of the schools.

For the NAPD programs, development has been an evolutionary process, not a prescription. There had been no assumption, explicit or implicit, that any answers were known. Many things were tried. Some worked, and the successes

gave direction to the effort. This is the embodiment of the "engineering approach" and it applies as well to problems in education as it does to new product development.

The programs deal directly with the needs of students and teachers and are well accepted by them. This "bottom-up" approach is often favorably contrasted with the more common "top-down" approach where change is mandated and a budget appropriated to implement prescribed programs.

As problems have been resolved, the programs have expanded. Each is directly responsive to local needs and conditions; yet each is part of a network linked in a positive relationship with one another through their common philosophy, overlapping program elements and shared procedures and experiences.

MODELS OF ORGANIZATION

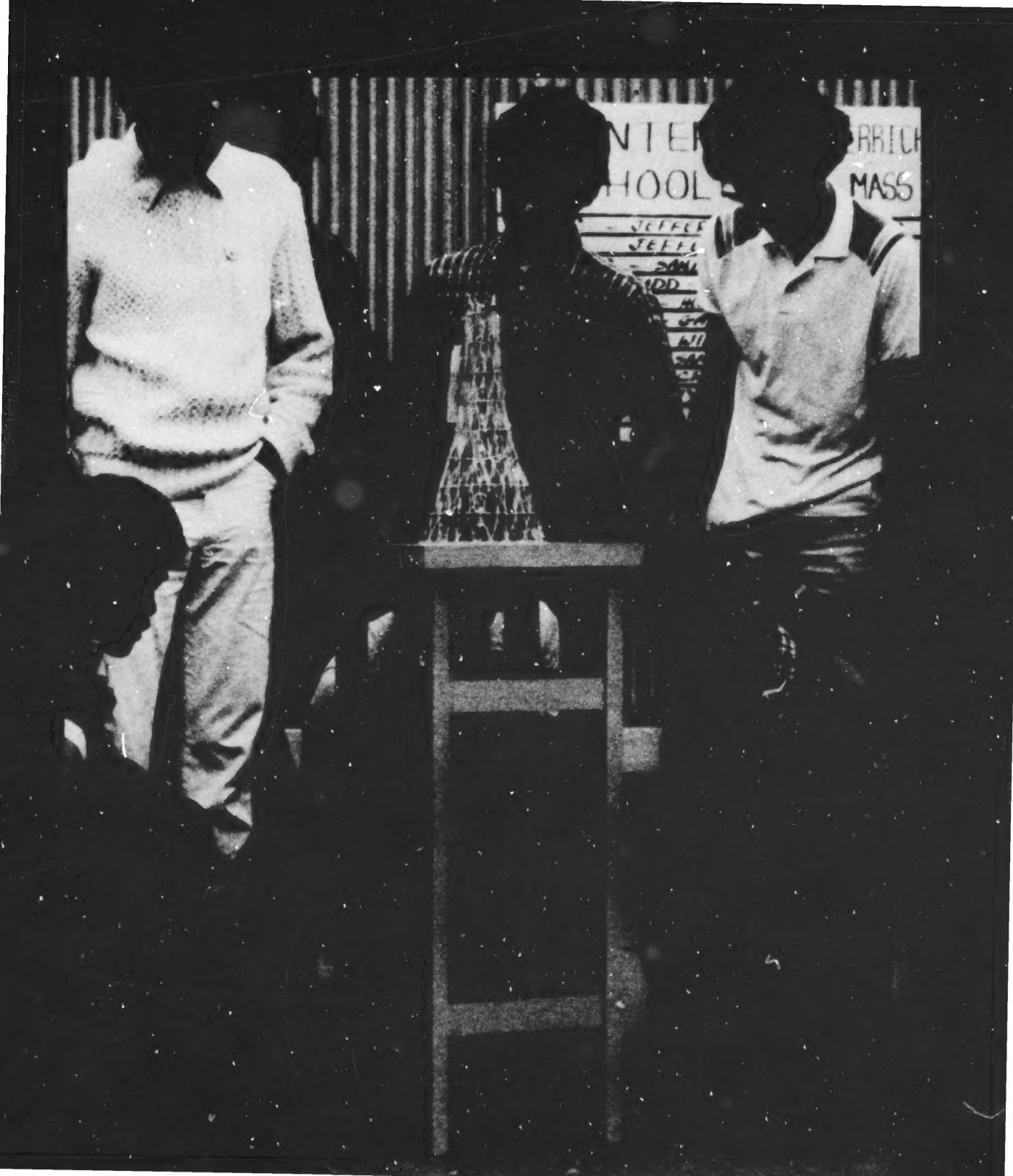
The mix of services provided by the NAPD programs differs from location to location, but always includes informational, motivational, and enrichment activities, and usually contains elements which strengthen the capability of the teachers and the schools. Most programs offer both school-year and summer activities. All concentrate on mathematics, science, and communications skills. In each program, the objective is to:

- provide assistance needed by student participants but which is not fully provided by the school,
- promote students' understanding of technical careers and ensure academic progress through constant individual monitoring and long-term support, and
- build self-esteem among students and a heightened sense of confidence necessary for achieving their academic and career goals.

All nineteen NAPD programs are described in Appendix A. Of those, there are five which are distinctively organized and collectively provide models of development for an extremely wide range of settings.

PRIME, the "Philadelphia Regional Introduction for Minorities to Engineering," has a very strong centralized organization. All of its activities are coordinated by a small staff guided by the Executive Director. PRIME staff persons deal directly with schools, teachers, students, businesses, and

EACH PROGRAM OPERATES THROUGH A SMALL STAFF WHICH IS NOT FROM INDUSTRY, BUT IS GUIDED BY IT; FREQUENTLY IS UNIVERSITY-BASED, BUT IS NOT PART OF THE UNIVERSITY ADMINISTRATION; WORKS CLOSELY WITH THE SCHOOLS AND THE SCHOOL BOARD, BUT IS NOT INTERWOVEN WITH THE PUBLIC SCHOOL STRUCTURE.


NTE
HOOL
RRICH
MASS

universities, and thus can closely control the quality of the effort. As with all NAPD programs, PRIME's Board of Directors, which includes members from the business, academic, and civic sectors, is actively involved with planning, fund raising, and monitoring the program's performance. PRIME is incorporated as a non-profit education organization and is housed in its own offices in central Philadelphia.

The "Comprehensive Math and Science Program" (CMSP) is largely a research and development project that creates and tests models of math and science curriculum and technical career guidance in a sample of high schools in New York City. Operating as a collaborative, the CMSP has organizational ties with the six New York City engineering colleges, locally based industries and the New York City Board of Education. Together they provide institutional resources to high schools participating in the project. The staff of the CMSP includes New York City math and science teachers and engineers assigned through IBM's faculty loan program, and a core development team from Columbia University. The CMSP operates under the aegis of the School of Engineering and Applied Science at Columbia University in consort with the High School Division and the Office of Career and Occupational Education of the New York City Board of Education.

California's MESA, Mathematics, Engineering, Science Achievement, has a less centralized organizational structure. The central program office is housed at the Lawrence Hall of Science, University of California at Berkeley. The statewide program operates through semi-autonomous centers. This allows maximum flexibility at the local level, while the statewide office provides umbrella services such as overall planning, workshops and conferences, evaluation, tracking of students, etc. Each center hires its own full-time Director and provides support to as many as a dozen individual schools in its vicinity. The center finds its own private sector support; it deals directly with the school system, it helps to organize parent support groups, and in most other ways operates as a free-standing entity. The MESA model has been adopted in neighboring states, and the central office makes little organizational distinction between centers in California and those outside the state.

TAME, the "Texas Alliance for Minorities in Engineering" has a somewhat more decentralized organization than MESA. It operates in fourteen areas of Texas through autonomous chapters which are linked only loosely to TAME's

central office and to each other. Each establishes its own relationship with the local school and with the university and industry in its area. It raises its own funds and decides what program services will be offered. TAME's central office serves a limited coordinating function and provides overall quality control through data collection and visitations. TAME is incorporated as a non-profit educational organization.

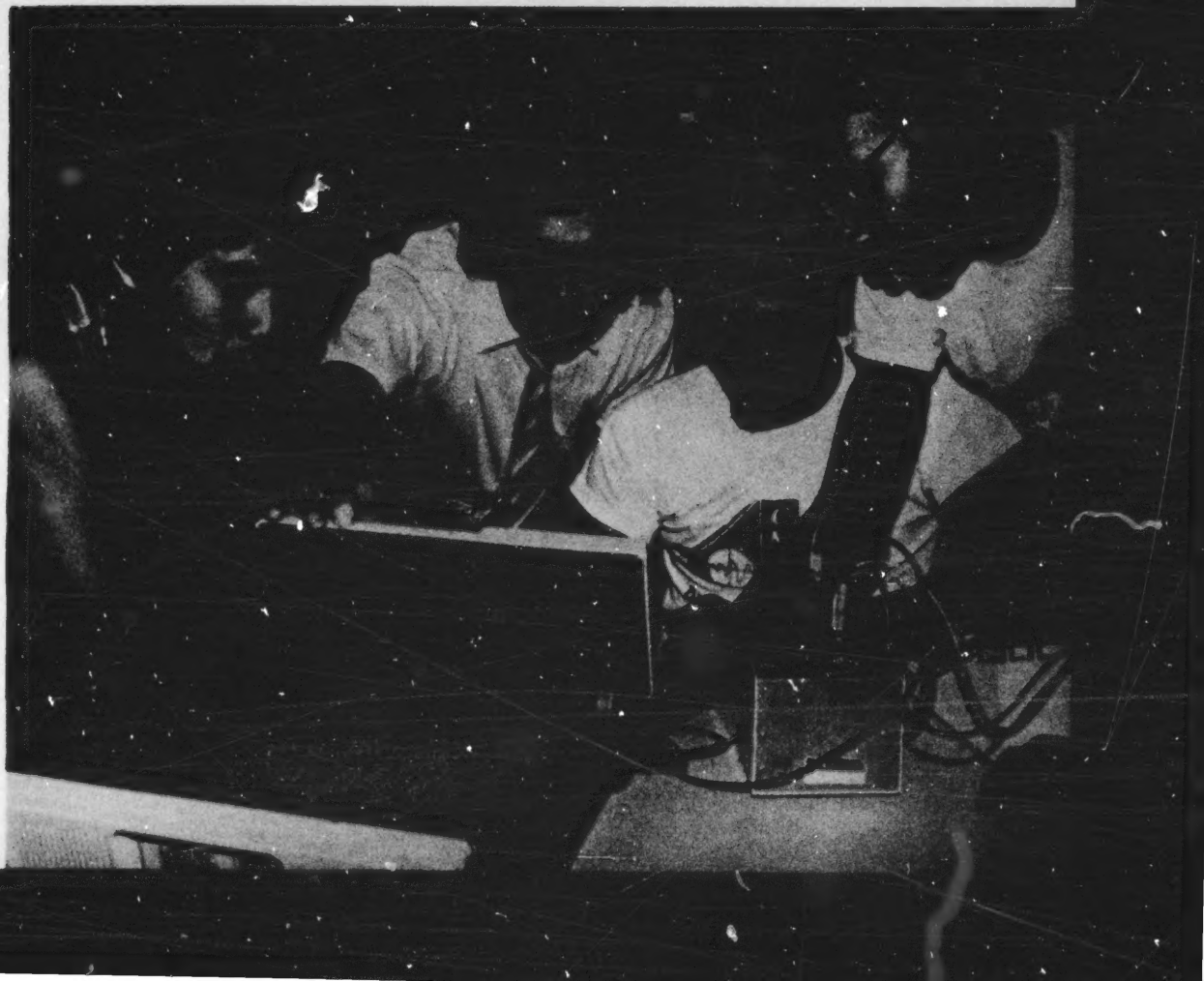
SECME, the "Southeastern Consortium for Minorities in Engineering," operates over an extraordinarily large area which encompasses both inner-city school systems and rural systems distant from any possible industrial support. It manages this by working through a decentralized structure while overseeing operations centrally. Individual SECME programs operate at the school system level. The local Program Director is responsible for guiding development of the program at the schools and for maintaining communication with the engineering faculty at the cooperating university, with industry consultants, and with the SECME office in Atlanta. This office provides a variety of resource materials and collects longitudinal data on the students. The most important unifying activity carried out by SECME's central office is the annual Summer Technological Institute, where teachers and school personnel from local SECME programs all over the region gather at a member university for a graduate credit course. Here they learn about SECME, about the engineering profession and about curriculum enrichment through teaching strategies and microcomputer techniques. The end product of these institutes is an implementation plan for the SECME program in individual schools and classrooms.

EXPERIENCE HAS SHOWN THAT THESE PROGRAMS ARE "TRANSPORTABLE"; THE ESTABLISHED NETWORK READILY SUPPORTS THE FORMATION OF NEW SITES.

Each of these five programs has achieved a structure which fits the local circumstances. PRIME's strong central control works well in heavily populated, urban areas. CMSP works intensively within individual schools to develop new models of mathematics and science curriculum and instruction. TAME's operation seems well-suited to the Texas pattern of medium to large cities separated by great distances. SECME's organization suits the mixture of urban and rural school systems found in the Southeast. MESA's university-based center system works very well in California, where the university network is extensive and reaches into virtually all portions of the state. Other NAPD programs have patterned their own structure after these five, sometimes combining elements from two or more. Experience has shown that these programs are "transportable"; the established network readily supports the formation of new sites.

LEARNING FROM EXPERIENCE: COMMON ELEMENTS WHICH PROMOTE SUCCESS

An immense amount of thought and energy has been devoted to the development of the NAPD precollege programs. Each program, whether spontaneously occurring or carefully modeled on another, strongly conforms to local needs so that even those with similar names are quite different from one another. (See Appendix A—Program Summaries.) Although the programs have come to their present state from different directions, a shared philosophy has created a large number of common elements which form the foundations for program success.



Program Structure

Any intervention should be a *long-term* venture. This makes effective planning and goal-setting possible and allows the program to evolve as it seeks to satisfy students' needs in additional ways. If a program has permanence, people are more willing to work with it and less likely to try to work around it.

The programs must provide *extensive interaction* with the students over a period of years. Once a student becomes involved, the program should maintain that student's involvement through high school graduation. Enlarging the pipeline at only one point does little good if constrictions remain farther along the path.

IF A PROGRAM HAS PERMANENCE, PEOPLE ARE MORE WILLING TO WORK WITH IT AND LESS LIKELY TO TRY TO WORK AROUND IT.

Early intervention should be a priority. Some programs originally selected participants after the students had "proven" themselves capable in mathematics (usually algebra), but it became apparent to all that the earlier the intervention, the better for the student. This is especially true in mathematics because, from the student's point of view, one bad experience with a school subject is usually enough to foreclose interest in it. Recognition of this has prompted MESA to expand from high school to junior high school, SECME to encourage students to start participating in eighth grade, PRIME to move into the elementary grades, and most of the more recently established programs to work immediately at the seventh or eighth grade level. All programs are moving toward the earlier school years as they search for a point of initial intervention which maximizes the benefits for the students.

The program should be a *collaborative effort* among local employers, the nearest university, and the school system. Each of these sectors has its own concerns, indeed, its own culture, but each has an important role to play in education. By bringing them together, the program not only marshals diverse forces to help solve educational problems, it also promotes a shared sense of community enterprise.

It is important that the effort should seek *multiple funding* from as wide a group of contributors as possible. Experience shows that single-source funding is rarely stable, whether it is from a government agency, foundation grant, or any other origin. With single source funding, the ultimate result is nearly always program demise. Funding priorities change, budgets are sometimes cut, and sympathetic people may leave the contributing organization. To have a chance at success, the program needs to be insulated from these occurences. With multiple funding, the flow of dollars is not

ENLARGING THE PIPELINE AT ONLY ONE POINT DOES LITTLE GOOD IF CONSTRICTIONS REMAIN FARTHER ALONG THE PATH.

always constant and much effort is needed to stimulate that flow, but the resultant economic stability is vital to program success.

The collaborative nature of the program should be maintained through a *formal mechanism* for participation which recognizes the contributions of local industry, business, community groups and parents. Representation of these groups on an advisory council or local board of directors is especially important. Their long-term interest will be better maintained if they see that their suggestions can affect the process.

Status as a *non-profit educational organization* is extremely beneficial. This can be done directly by incorporation or indirectly by organizing the program within the larger structure of a non-profit institution such as a university. The major advantage of the non-profit status is that donations of money and equipment from local business are more readily attracted and received.

All of the programs benefit from receiving *in-kind support*. This can range from printing a brochure or hosting an important meeting to covering the significant costs of an employee's salary while that person devotes time to the program effort. Many companies can make in-kind contributions more readily than cash contributions, while others will enthusiastically make both. Several NAPD programs have secured large in-kind contributions which expand their operating budgets significantly.

Program Functions: Teachers

Positive teacher attitudes toward engineering and math-based careers greatly influence student attitudes. In education research, the teacher has been found to be the single greatest influence outside the home on the student's career choice. The more a teacher knows about technical careers and the academic prerequisites for them, the more effective that teacher will be because there are 180 opportunities a year to influence the student. The teacher holds the key to effective academic preparation; it is the teacher who can relate subject matter to career activities and thus perform a guidance function. Where the programs operate in the schools, the teacher is recognized as the critical agent of change. SECME, for example, has formalized this link by granting graduate-course credit for its Summer Institute which has trained over 800 teachers. PRIME has trained nearly 400, and most of the other programs carry out some activities designed to augment teachers' abilities, to make them more knowledgeable about science and engineering careers and more responsive to students' interests in that direction.

There is a conscious effort to *enhance the status of the teachers* associated with the programs in order to improve self-esteem and develop self-confidence. Most programs recognize outstanding contributions through "Teacher of the Year" nominations and awards or through the conferring of "Master Teacher" status. In addition, most programs promote career development by selecting capable teachers for coordinator roles which allow them to sharpen their organizational and managerial skills. Finally, and most commonly, the success of a program naturally moves the teachers associated with it closer to the center of the spotlight; they become known within the school system and to the parents and the community. Once a program is established, teachers have found their involvement with it personally satisfying and professionally rewarding.

ONCE A PROGRAM IS ESTABLISHED, TEACHERS HAVE FOUND THEIR INVOLVEMENT WITH IT PERSONALLY SATISFYING AND PROFESSIONALLY REWARDING.

There are program elements which *help the teachers do their job better.* In addition to program-sponsored teacher training, there are day-to-day links with the university and industry. These show teachers how their subject matter relates to actual research or operations and provide concrete examples the teachers can use in the classroom. The industry links also keep teachers abreast of new technologies, especially in the computer field. Indeed, many teachers have become familiar with computers and computer applications for the first time through NAPD programs.

The programs all provide frequent opportunities for sharing experiences among teachers. Within schools, science, mathematics, and English teachers are generally organized into teams which plan program activities cooperatively and coordinate instruction. This promotes professional association across discipline lines, often for the first time in the teachers' experience. There is also ample opportunity for teachers from different schools to meet on "neutral" territory independent of the school system to trade techniques and gain insight into the workings of the program under circumstances different from their own.

Program Functions: Students

IT IS CLEAR THAT A SOLID ALGEBRA BASE FACILITATES STUDENT COMMITMENT TO A PRECOLLEGE SEQUENCE OF MATH AND SCIENCE COURSES.

An *early* student *commitment* to science and mathematics course sequences is very important. Many NAPD programs begin involvement with students at the ninth grade, as the students begin algebra. Others, observing that students who delay algebra until ninth grade are not likely to take enough mathematics in high school to qualify for engineering or science studies, intervene earlier in the education process. It is clear that a solid algebra base facilitates student commitment to a precollege sequence of math and science courses.

All programs offer students a *mix of services*. The mix differs among programs but always includes informational, motivational, and enrichment activities. Academic advisement, career counseling, role models, tutoring, supplemental curricula, field trips, and classroom projects are common. The objective is to provide a context within which consideration of engineering and other math-based fields is facilitated and natural.

All programs improve the students' *time on task* in science, mathematics, and language arts courses. CMSP does this very explicitly by doubling instruction hours. Other programs do it in other ways, such as organizing group homework sessions, after school programs, and summer involvement. In the classroom, there is more learning and less disruption when teachers can make the subject matter more interesting, when students put more time and energy into their studies, and where good preparation means less class time needed for review of old material.

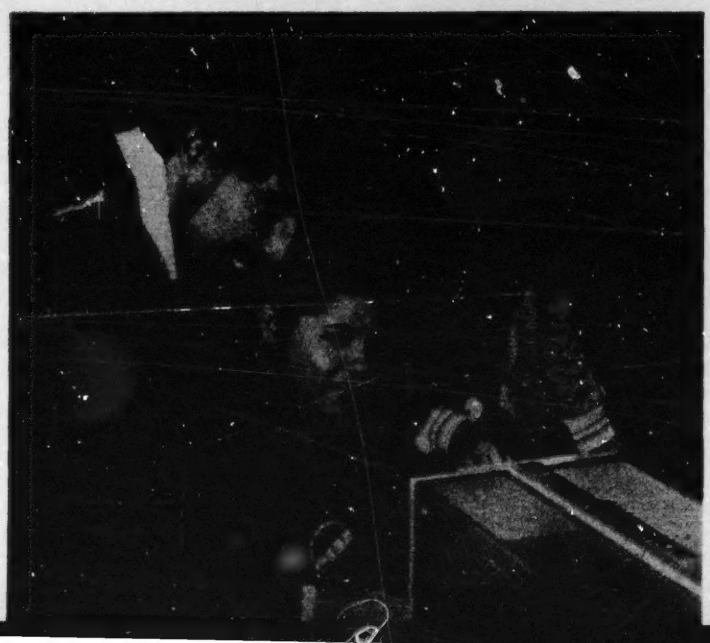
Students' *problem solving abilities* are sharpened. Nearly all programs concentrate on problem solving strategies and practice as part of the classroom experience. They place special emphasis on the relation between classroom science

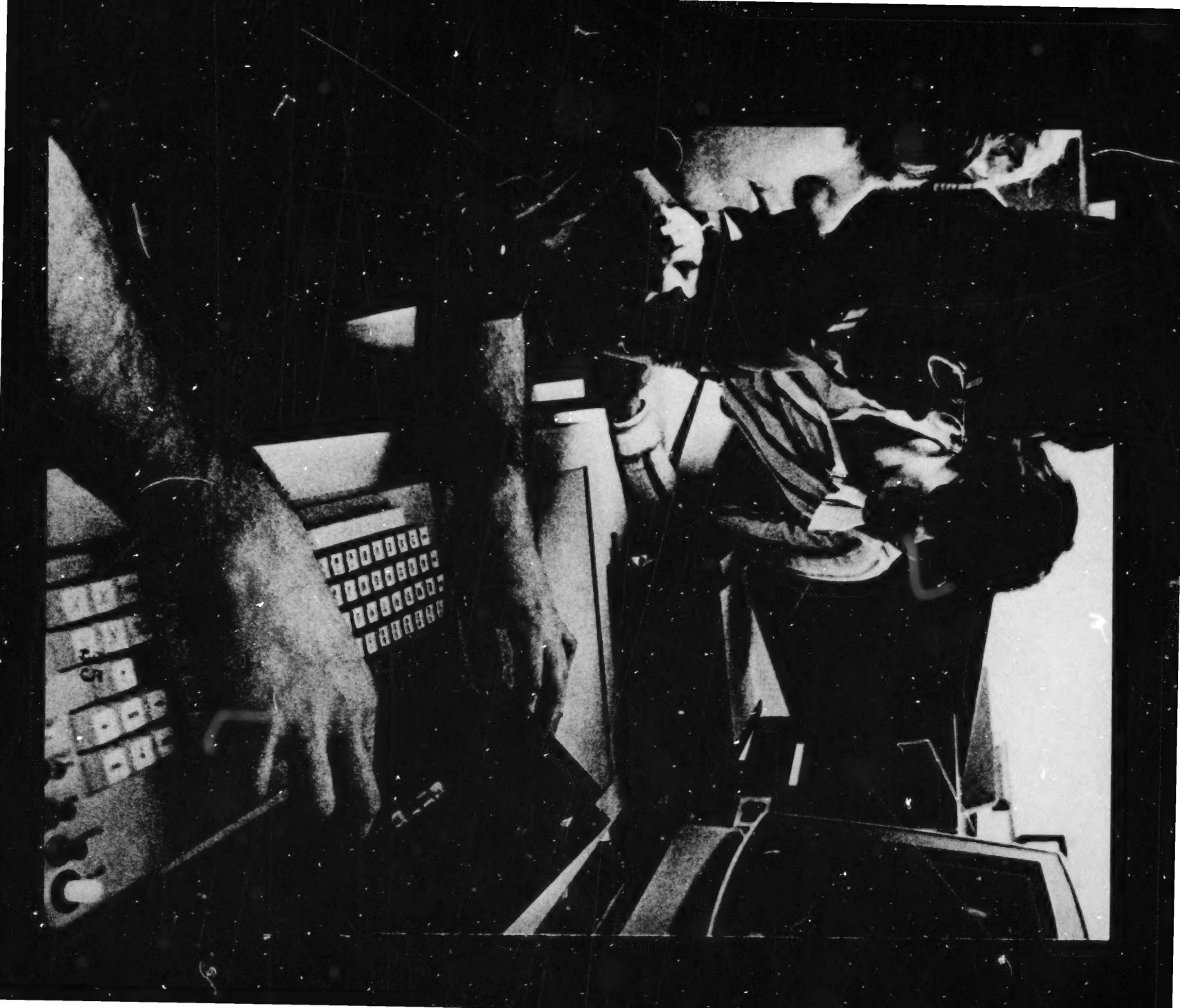
and mathematics problems and real-world applications. To do this they invite industry representatives to the classroom, visit industrial sites and university laboratories, and apply textbook principles to the practical task of completing individual special individual projects.

Longitudinal tracking is important for a variety of reasons. Typically, it lets the programs know how well the students do in their courses, which careers the students prepare for and, often, where the students have gone to work on their first job following college graduation. Tracking helps to pinpoint problem areas and to guide the program toward more effective use of its resources. Further, it provides important feedback to school systems and individual schools. Finally, tracking gives tangible data on program impact to industrial sponsors, community organizations, parent groups, and other supporters. Though a few national studies* have followed groups of students from year to year, the longitudinal tracking carried out by these NAPD programs is the only broad-scale attempt in the country to follow individual students as they progress through their high school and college careers, as well as the only one to focus on engineering, science, and other math-based fields.

TRACKING HELPS TO PINPOINT PROBLEM AREAS AND TO GUIDE THE PROGRAM TOWARD MORE EFFECTIVE USE OF ITS RESOURCES.

* Two multi-year longitudinal studies initiated by the National Center for Education Statistics are the "National Longitudinal Study: The High School Graduating Class of 1972" and "High School and Beyond," which is studying a large sample of students who were high school sophomores and seniors in 1980.





Motivational Activities

The programs all stress improved *two-way communication* between teacher and student. Because of the resources the program brings to the classroom, the teacher can spend more time with the students engaging in dialogue which goes beyond normal academic learning. The resulting quality of teacher-student interaction is very high.

The coordinated math/science/language *team approach to class instruction*, a feature of most programs, helps the students understand that these subjects will be part of their future adult life experience, not merely unrelated school subjects to be taken and forgotten.

All programs establish a *peer support group* for their students. MESA operates as a science club within the school system, SECME schools set up science clubs to supplement classroom activities, CMSP and PRIME participants attend classes as a group, and the other programs all have a mechanisms for helping students feel they are part of something special. The prestige of being identified as a specially selected student has a motivational effect not only on the individual, but also on non-participating peers and younger students.

THE PRESTIGE OF BEING IDENTIFIED AS A SPECIALLY SELECTED STUDENT HAS A MOTIVATIONAL EFFECT NOT ONLY ON THE INDIVIDUAL, BUT ALSO ON NON-PARTICIPATING PEERS AND YOUNGER STUDENTS.

Nearly all programs have specific ways to *recognize student achievement*. Program participants can win cash awards, calculators, or scholarships for superior performance. Most programs host end-of-year awards banquets attended by the students, their parents, their teachers, and many people from the university and local business involved with the program. This recognition is important to maintain morale at a high level and satisfy the basic human need to feel rewarded for one's achievement.

In summary, the structural features and program functions described above are part of each NAPD program. Most have evolved as a result of a lengthy trial and error process that has led to a system of services that can be delivered in a variety of ways—and are. This flexibility of the NAPD model is its greatest asset.

CONCLUSION

The precollege programs represented by the National Association of Precollege Directors (NAPD) constitute a large scale coordinated effort to increase the pool of minority high school students with the academic qualities and resolve to pursue college study in engineering. Born out of a concern for the small number of minorities in the engineering professions in 1973, NAPD programs have evolved into broad based models of school intervention that over the years have increased significantly the educational and career opportunities for tens of thousands of young high school students across the country.

NAPD programs are currently serving well over 30,000 students from large school systems located in densely populated urban centers as well as school systems located in less populated urban and rural areas of the country. In almost all instances the organization and development of individual NAPD programs was initiated by *private sector funding*. Although the initial donors were few in number, the programs now attract support from multiple funding sources which include a large number of engineering employers. This support mechanism has paid rich dividends not only by furthering program goals, but also by establishing long term stability and allowing the programs to increase their funding base through matching school system appropriations.

Although each of the nineteen precollege programs that comprise NAPD has developed and evolved in its own unique way, all are characterized by strong *collaborative* ties with engineering employers and colleges in the school communities which they serve. This collaboration has provided a basis for the blending of institutional resources that give NAPD participant schools substantial leverage and flexibility for making school mathematics and science programs more challenging and rewarding to students. It has also given mathematics and science teachers valuable sources of information and has created an environment in which they can enrich their teaching and advisement of students.

The evolution of NAPD programs, while directed towards engineering, has matured into a comprehensive effort aimed at improving in wholesale fashion the learning experiences of young people. What has emerged in participant schools is a spectrum of services and activities that goes far beyond that which is generally available in traditional school

programs. *College and industry sponsored seminars, science fairs, special college programs for students and teachers, continual student academic assessment, emphasis on college and career guidance, visitations to industry sites, engineering applications to mathematics and science instruction and interschool networking* are just some of the multi-faceted activities that comprise NAPD programs. These are not just one shot events but instead are scheduled regularly throughout the academic year and in the summer. While participating in these special program activities, students put forth their best efforts under the guidance and tutelage of teachers and NAPD staff who work together to broaden the education of students both *inside and outside* the school environment.

In large measure NAPD programs function as very special educational extensions of participant schools. Aptly described as *third party* models, they serve as both *catalyst and resource* to help students and schools adapt to the rapidly changing world of science and technology. Their engineering college affiliation and strong connections to industry ensure this through real world applications made available to students to complement mathematics and science instruction. It is this focus on technology and access to timely resources that make NAPD programs effective in *promoting success* in students who choose to pursue engineering and math-based college studies.

NAPD programs represent the state of the art in *collaborative ventures in precollege science and mathematics education.* Started as private sector initiatives with a determined purpose to nurture the academic potential of minority students, NAPD efforts have developed into model networks of school intervention. Their presence in school communities throughout the country has stimulated a process of change through which schools work cooperatively with surrounding industry and colleges to make education more realistic and meaningful to students and teachers. The return on the private sector investment is continually demonstrated as significantly more minority high school students excel in their academic work and greater numbers enter promising careers in engineering, science and technology.

APPENDIX A

Program Summaries

There are more than 100 minority precollege science and mathematics programs around the country (a lengthy list of programs is included in NACME's Precollege Directory, 1984 edition), only a few of which are comprehensive, multiple-funded efforts. Of the latter, most are members of the National Association of Precollege Directors, the only associated group of these programs in the country. It is the NAPD membership organizations which are the subject of this document.

Each of the NAPD programs is described in this Appendix. For more information, the reader is encouraged to contact NAPD c/o NACME or the individual programs.

BEAM

The Buffalo Area Engineering Awareness for Minorities program began in 1983 as a joint effort of local industry, the State University of New York at Buffalo, and the Omega Psi Phi service fraternity. BEAM identifies potential minority engineering students in the seventh through twelfth grades at participating junior and senior high schools. The twice-monthly in-school programs are led by engineers from local companies who give demonstrations, take students on field trips and guide hands-on projects in order to provide students and teachers with a better understanding of the engineering professions. The BEAM organization assists students in identifying the high school courses required for admission to college engineering programs, encourages them and provides

tutorial support. Science and mathematics teachers work with engineers to develop more effective curricula, to provide students with career education activities and to apply classroom learning experiences to the solution of engineering problems.

Students are given opportunities to visit college campuses to familiarize themselves with engineering program offerings, to observe research activities and to consult with engineering students and professors. BEAM also conducts a six-week college credit summer program for talented post-eleventh grade students.

Though BEAM originally operated in the Buffalo School System, it has now extended its programming to all of the Western New York Region. This area includes four American Indian reservations which BEAM serves in special ways.

CAPCEP

The Chicago Area Pre College Engineering Program is designed to increase the number of minorities (including women) in engineering and technical careers. It provides technical, financial and administrative assistance to Chicago area public and private school systems to enrich the academic curriculum

and develop student interest in these careers. A teacher training project is being conducted by the National College of Education for teachers in the Chicago school system.

CMEA

The Colorado Minority Engineering Association operates both a precollege program (MESA) based on the California MESA model and a university level Minority Engineering Program (MEP). Though recently instituted (1980), the MESA program operates within more than 50 schools in seven key districts and reaches over 800 students throughout the state.

CMEA activities begin at the seventh grade and extend through twelfth grade. Students are selected on the basis of their interest in mathematics and science-related careers and on their potential for achievement in high school. They must agree to participate regularly in MESA activities and to enroll in college preparatory courses, including four years each of mathematics, science and English.

CMEA's MESA program provides tutoring, specialized counseling, role models, speakers, monetary incentives, field trips, full parent involvement, career awareness/preparation, and science and engineering special projects. Summer activities have included both "bridge"and enrichment programs operated through universities or in conjunction with local community organizations.

CMEA is a private non-profit corporation based at the University of Colorado at Denver. Its operations are funded entirely by the private sector.

CMSP

The Comprehensive Math and Science Program operates as a field based research and development project engaged in creating and testing models of mathematics curricula and instruction in several New York City high schools. The model development effort is conducted during the regular school day as a joint venture of the CMSP with the New York City Board of Education, making it unique among NAPD programs.

Founded in 1974, CMSP functions as a collaborative in New York City with the six locally based engineering colleges and industry, providing resources to support high school project activities both in and outside of the school environment. In the 1983/84 academic year, over 2,500 students participated in a variety of academic and career oriented CMSP

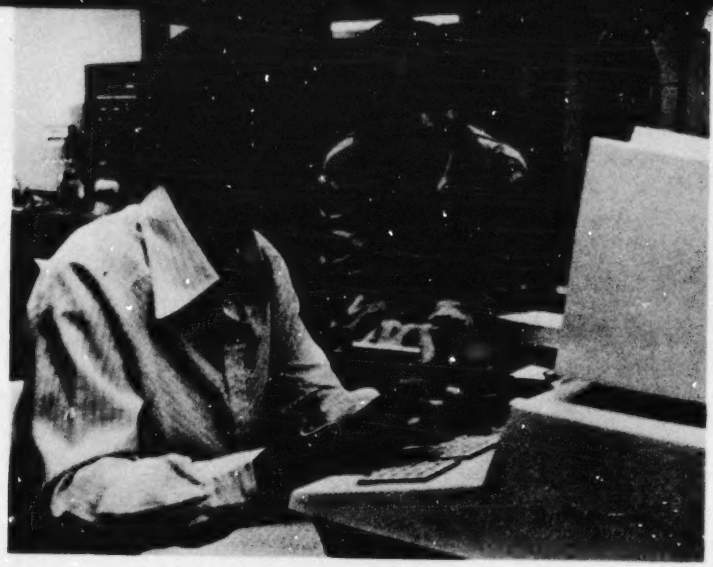
programs and events that make up the total CMSP effort. Its major focus has been an Algebra and Geometry program which restructures the first two years of high school mathematics. This curriculum based model allows incoming ninth year students to build a strong mathematics foundation by integrating math courses with science topics and computer applications. Initial mathematics model development began in 1979, and since then over 3,000 students have studied Pre-Algebra and Algebra using this highly structured model.

Other CMSP initiatives include a series of Seminars on Careers in Engineering, Technology and Computer Science for juniors who visit local engineering colleges and also attend special industry seminars at their home school, in addition to the College Fair for Engineering and Technology held at Brooklyn Technical High School (which annually attracts 600 juniors and seniors from 15 high schools to meet with admissions staff and faculty from 40 engineering colleges and military academies).

The CMSP operates under the aegis of the School of Engineering and Applied Science at Columbia University in consort with the High School Division and the Office of Career and Occupational Education of the New York City Board of Education. Institutional and grant support for project development and management comes from the private sector with matching budget allocations for school based expenses supplied by participating high schools and school board project offices.

DAPCEP

The Detroit Area Pre-College Engineering Program, founded in 1976, works with the Detroit Public Schools and six area universities to provide enrichment classes and program support for junior high and high school students interested in engineering and other technical careers. The program, which serves 1,300 students from 30 Detroit schools, has three interrelated components: A Summer Skills Intensification Program, Saturday Morning Enrichment Classes, and In-School Pre-Engineering classes. There is also an active and supportive parents advisory group and an after-school tutorial program run by DAPCEP graduates now in college. DAPCEP receives funding and technical support from about two dozen major corporations, foundations and other organizations. Presently, there are nearly 200 DAPCEP students pursuing engineering study throughout the country.



FAME

The Forum to Advance Minorities in Engineering was organized in 1977 and has grown to be a broad-based, community-wide program in the greater Wilmington, Delaware area. FAME's goal is to motivate students to pursue and succeed in science and mathematics. Approximately 250 students in the seventh through the twelfth grades meet periodically for various programs, including a Saturday Calculus Club sponsored by the University of Delaware for twelfth grade students, a test awareness program offered bi-weekly for all students, and a number of special events and activities. There are also summer enrichment activities for grades seven through twelve, prefreshmen summer employment at one of the sponsoring industries, and off-to-college nights where prefreshmen receive assertiveness training. FAME's director is an E.I. duPont Company employee on special assignment, and the program is supported by more than two dozen other companies and community organizations.

GEST

The Gateway to Engineering, Science and Technology program, based at the University of Wisconsin in Milwaukee, was established in its present form in 1975. Using the IIT model of Saturday enrichment activities (see next program description), GEST recruits highly capable minority secondary students throughout the city who meet for mathematics and science programming at the university during the school year. At these Saturday sessions, students get a taste of college life by attending lectures, working with computers, and performing laboratory tasks which demonstrate the link between

science and engineering. The seven-week summer program meets daily to focus on engineering design along with math and science academic study. The best of the summer students are chosen to carry out their design projects with the assistance of university engineering faculty. This effort results in a working model which demonstrates some aspect of the application of science to everyday life. While carrying out these projects, the students experience both the frustrations and the satisfactions which are part of the normal course of engineering development.

During the school year, a number of the student-produced models are displayed for a week at a time at six Milwaukee area secondary schools. The purposes of this Mobile Science Display are to help educate the 1,500 students per year who have an opportunity to interact with and learn from the models, and to promote the GEST program among both the students and their teachers.

IIT

The Illinois Institute of Technology Minorities in Engineering Program was started in the Chicago area in 1973, making it among the oldest of the NAPD efforts. It now includes pre-college engineering, precollege medical, and college retention elements. In order to participate, students must be in the tenth grade and currently taking regular college preparatory second year mathematics. The program stresses talent, and the number of students accepted is kept to a modest level so that each can get individual attention at all times, thus greatly improving their chances of success in college. While the program includes intensive motivational and informational activities, its main thrust is individual academic preparation in mathematics and science with a heavy emphasis on "hands-on" laboratory experiments. These activities spread across the entire year including seven weeks of all-day summer work. Diagnostic tests are used to determine math and reading deficiencies, and students are grouped and tutored accordingly.

Each year IIT works with 450 students in the pre-college effort, one third of whom go on to engineering study, while nearly all the others engage in other math-related curricula. As of June, 1984, close to 1,000 former IIT precollege program participants had received an engineering degree, and the IIT precollege model has been used as the basis for programs at seven other colleges.

LEAP

The Louisiana Engineering Advancement Program was founded in 1980 and operates from centers located in New Orleans and Lake Charles. Activities include regular group meetings, study and tutorial sessions, field trips, presentations by practicing engineers and an incentive awards program. Presently, there are about 300 student participants in grades seven through twelve. Criteria for entry to LEAP are purposely kept liberal in order to maximize participation, but once involved, students are expected to maintain a minimum 2.50 grade point average and to enroll in all of the available prerequisite engineering mathematics and science courses. LEAP is based at Xavier University in New Orleans and program activities are underwritten by more than two dozen businesses and foundations.

MASSPEP

The Massachusetts Pre-Engineering Program for minority students began in the Boston and Cambridge school systems in 1979. Currently, 300 students at eight schools participate in the MASSPEP program. Each MASSPEP school forms a planning team consisting of mathematics, science and English teachers and a guidance counselor. One of these members is responsible for developing and implementing the program which has a school club format and meets weekly. The in-school program includes activities which help the students develop a positive achievement orientation, expose them and their teachers to technology and its opportunities, and bring in technical volunteers to act as first-hand sources of information and role models. The summer program is operated in conjunction with local engineering colleges and helps students supplement their school program and acquire advanced technical skills. MASSPEP coordinates a consortium composed of the school systems, a number of industrial sponsors, the Boston Museum of Science and the six Boston area engineering universities.

MESA/California

Mathematics, Engineering and Science Achievement is designed to increase the numbers of underrepresented ethnic groups in professions related to mathematics, engineering and the physical sciences by providing precollege programs at both the high school and junior high school levels as well

as a university retention program. In 1970, the MESA pre-college program began with 25 students in Oakland Technical High School in California. Today, it serves 4,049 students from 139 California high schools and provides support for associated MESA programs in New Mexico, Colorado, Washington, Arizona and New York.

To be selected as participants, students must have completed Algebra I, be enrolled in an academic math course and have at least two years remaining before high school graduation. Most candidates are identified through teacher, counselor or administrator recommendations, but many come to program attention through pre-MESA activities for younger students. Specific services of the MESA precollege programs include: tutoring; independent study groups; academic, university and career advising; field trips; summer enrichment and employment programs; and scholarship incentive awards.

Results have been gratifying. More than 90% of MESA high school graduates enroll in college. MESA high school students achieve a mean Mathematics SAT score approximately 75 points higher and a mean Verbal SAT score approximately 35 points higher than the average for non-MESA college-bound students from similar ethnic backgrounds in California. Among the minority women high school graduates who have participated in MESA, five times as many plan to become engineers than do their non-MESA counterparts in California.

MESA/New Mexico

The Mathematics, Engineering and Science Achievement program in New Mexico began its operations during the 1982-83 school year in the Albuquerque, Bernalillo and Socorro public school systems. The two MESA Centers which serve those areas are located at the University of New Mexico and New Mexico Institute of Mining and Technology, both of which have strong engineering and physical science departments. The program is based on the model developed by MESA/California, and that program provided considerable assistance to the New Mexico effort during its planning and early implementation stages.

Students are selected at the eighth and ninth grade levels on the basis of expressed interest in mathematics and science-related careers and are required to enroll in college-preparatory mathematics and science courses and to participate in MESA activities until they graduate from high

school. The program includes tutoring by engineers, scientists and college students; academic, university and career counselling; field trips; scholarship incentive awards for students who maintain a high grade point average in advanced level college preparatory mathematics, science and English courses; and summer enrichment and employment programs. In addition to the junior and senior high school programming, MESA/New Mexico provides minority college students with a wide range of supportive services through coordination of corporate, government and university resources. Though still in its formative period, the MESA program in New Mexico is presently reaching more than 300 students in 10 schools and has concrete plans for expansion not only within the present schools, but to new schools, and to additional school systems by establishing new MESA Centers at universities throughout the State.

MESA/Washington

The Washington State Mathematics, Engineering, Science Achievement program began in 1982, but is built on earlier elements, some of which were in place in 1972. It is patterned after the California MESA program and retains most of that effort's significant characteristics.

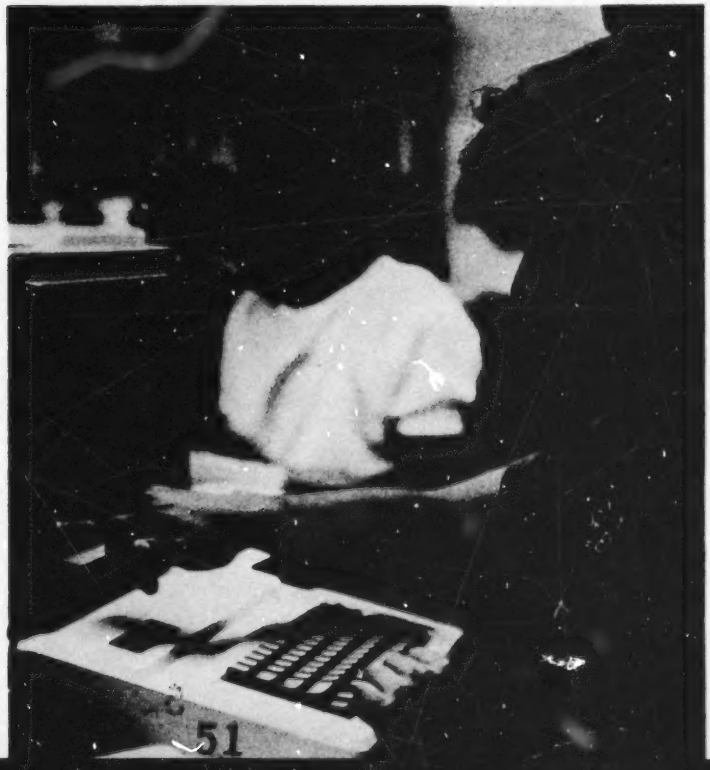
The program operates from a series of Centers located at universities with strong engineering and physical science curricula. Faculty sponsors at each Center organize an advisory board and establish relationships with local engineering companies, professional associations and community organizations.

MESA/Washington is working with 2,500 students in 11 schools at both the junior high and high school levels. Its participants are nominated by their teachers on the basis of above-average grades in mathematics and science as well as their potential to pursue and succeed in college engineering study. Students must agree to take a four-year academic sequence of mathematics, science and English courses. MESA/Washington provides a broad in-school program designed to enrich the students' regular educational activities. Elements include tutoring, independent study groups, academic/university/career advising, field trips, and scholarship incentive awards. There is also a summer employment program and a five-week summer enrichment program.

The activities of MESA/Washington are supported by more than a dozen major industries and foundations.

METCON

The District of Columbia Metropolitan Consortium for Minorities in Engineering is a group of engineering schools and organizations from the public and private sectors which have established a link between the public school systems and technology oriented resources in the Washington, D.C. metropolitan area. Currently working with 17 junior and senior high schools (grades seven through twelve), the program provides once a week contact which includes speakers, trips, science projects and an annual engineering orientation for eighth-grade students and their parents. In addition, METCON conducts an annual Summer Orientation Program for students and a Summer Workshop for teachers on the campus of Howard University. Work experiences in conjunction with the National Oceanic and Atmospheric Administration, the Department of Energy, the National Bureau of Standards and the General Electric Company provide selected students with technically oriented exposure to the day-to-day work of engineers at universities and several government agencies. The activities of METCON are supported by more than 20 major industries and federal agencies.



PRIME

The Philadelphia Regional Introduction for Minorities to Engineering began operations in the Philadelphia school system in November of 1973 and expanded to include Camden, N.J. schools the following year. Its network now includes forty area businesses and government agencies, nine universities and colleges, thirty middle and senior high schools, and several parent and civic organizations. About 1,650 students a year, selected on the basis of interest and math ability, are provided with a structured, in-school program from the seventh through the twelfth grades. Support services are also furnished to about 500 college students.

PRIME has long been a leader in the minority precollege effort. A decade ago, PRIME pioneered the "adopt-a-school" concept by pairing corporate sponsors with individual schools. The idea of a consortium of business, university, and school system interests has been part of PRIME's concept from the beginning. The PRIME Universities' Program (PUP) was initiated in 1976. It brings the best of its student participants through four successive summers of specialized programming at a different area university each year. They study mathematics and communications skills, work in an engineering laboratory and participate in engineering design activities.

Over the years, nearly all of PRIME's graduates have gone on to college. Of those, 60% have studied for engineering and other math-based careers.

PRIS²M

The Program for Rochester to Interest Students in Science and Math operates under the sponsorship and fiscal support of the Industrial Management Council of Rochester, a local manufacturers' association. Implementation of the program began in 1978 with the endorsement of the City School District and the leadership of the minority community. PRIS²M is now working with approximately 400 students in ten junior and senior high schools. The program focuses on problem-solving science curricula for junior high students, summer workshops for selected students, forming of science teams of approximately 20 students each at grade levels nine through eleven, industry internships for post-eleventh grade students, college orientation courses, and the "PRIS²M PROS" program, a role model support effort.

PRIS²M was established as a long-term initiative by the IMC, and the secure base of support has promoted innovative responses to changing conditions over the years. For example, the science curricula for the seventh and eighth grades developed by PRIS²M are in the process of validation by the State Education Department. Once approved, several thousand junior high students in Rochester will be impacted every year.

SECME

The Southeastern Consortium for Minorities in Engineering was established in 1975 by the Deans of Engineering from seven Southeastern universities. Today, SECME's network is the largest in the country, linking 23 universities and 50 corporations with 160 schools and more than 12,000 students in seven Southeastern states.

The program works within the existing education structure at the secondary school level. At each participating school, a SECME Team is formed to plan and carry out the program. The team usually includes the principal, a counselor, a math teacher, a science teacher and an English teacher.

Team members are trained by SECME at a Summer Institute held for two weeks at a different engineering school campus each year. Education faculty join engineering school faculty and SECME staff to conduct the Institute which is designed to help attendees understand SECME's goals, to teach new methodology for curriculum enrichment, to use the microcomputer as an instructional tool, to explain the opportunities in the engineering profession and to review the requisites for successful engineering study. Participants work with their school system colleagues, engineering faculty and industry consultants to develop an implementation plan for their classrooms and to coordinate a SECME program in their home schools.

The local SECME program is a grassroots effort and typically has direct links with the faculty at an engineering school as well as support from community organizations. It raises cash and in-kind contributions from local sources and is often able to provide summer technical employment for students.

Student participants are identified as early as the sixth grade. Nominations come from teachers or counselors and include both those students who are achieving and those with the potential to achieve. Overall, more than 85% of graduating

SECME seniors attend a college or university and more than half of those opt for engineering or other math-based pursuits.

TAME

The Texas Alliance for Minorities in Engineering was started in 1973, when a group of educators and corporate executives in Dallas, concerned about the nearly total absence of minority students in Texas' university engineering programs, set out to stimulate corporate interest in helping resolve the problem. A pilot effort in twelve Dallas high schools quickly demonstrated the interest of minority students and the willingness of local industry to support that interest. Since then, TAME has expanded to fourteen chapters located in school systems throughout the state.

TAME has been a pioneer in the use of volunteers, and the chapters are able to function on very modest budgets because of that. Loaned industry executives direct each chapter and of the more than 700 people associated with the Alliance, only one, the Executive Director, is paid by the program.

TAME has also been in the forefront nationally because of its linkage between industries and schools. Adopt-a-school programs are a key feature of most TAME chapters. Specific program features differ from chapter to chapter, but all provide varied services to the participants during school,

after school and in the summer.

Students can become a part of the TAME program as early as the seventh grade and are selected on the basis of their interest and their abilities in mathematics, science and English. Teacher and counselor recommendations are also important, especially for identifying students whose potentials have not yet been realized.

Among the high school graduates of TAME, approximately half have opted for an engineering curriculum in college. Today, minority students make up 17% of Texas' engineering school enrollment.

UCMEP

The Union County College Pre-College Program began in 1979 in four Union County, New Jersey school districts. Operating in grades seven through twelve, UCMEP emphasizes mathematics, science, technology and communications skills. The student participants (nearly 500 in 1984) receive supplemental instruction in those subject areas as well as close supervision of progress by a designated guidance counselor. The program also coordinates field trips and provides role models to stimulate student interest in technical careers. Summer programming is designed to sustain that motivation and to provide broader experiences in engineering through emphasis in successive years on mathematics, communications, science and engineering projects.

APPENDIX B

NAPD Members *January, 1985*

BEAM	Buffalo Area Engineering Awareness for Minorities. 221 Fronczak Hall, SUNY at Buffalo, Buffalo, New York 14260. James Legge, Director.
CAPCEP	Chicago Area Pre-College Engineering Program. 300 West Adams Street, Chicago, Illinois 60606. Deborah A. Minor, Executive Director.
CMEA	Colorado Minority Engineering Association, Incorporated. College of Engineering, University of Colorado at Denver, 1100 14th Street, Room 517, Denver, Colorado 80202. Miguel A. Garcia, Executive Director.
CMSP	Comprehensive Math and Science Program. School of Engineering and Applied Science, Columbia University, New York, New York 10027. Gil Lopez, Director.
DAPCEP	Detroit Area Pre-College Engineering Program. Rackham Memorial Building, 60 Farnsworth, Detroit, Michigan 48202. Kenneth Hill, Director.
FAME	Forum to Advance Minorities in Engineering. Room N-13535, 10th and Orange Street, Wilmington, Delaware 19898. John H. Mathis, Executive Director.
GEST	Gateway to Engineering, Science and Technology. The University of Wisconsin at Milwaukee, P.O. Box 784, Milwaukee, Wisconsin 53201. Rose Daitsman, Director.
IIT	Illinois Institute of Technology Minorities in Engineering Program. Building E-1, Chicago, Illinois 60616. Nathaniel Thomas, Executive Director.
LEAP	Louisiana Engineering Advancement Program for Minorities. Xavier University, New Orleans, Louisiana 70125. George W. Baker, Executive Director.

MASSPEP	Massachusetts Pre-Engineering Program. Wentworth Institute of Technology, 550 Huntington Avenue, Boston, Massachusetts 02115. Richard Mullins, Executive Director.
MESA/ California	Mathematics, Engineering and Science Achievement. Lawrence Hall of Science, University of California, Berkeley, California 94720. Esteban Soriano, Executive Director.
MESA/ New Mexico	Mathematics, Engineering and Science Achievement. University of New Mexico, Farris Center 345, Albuquerque, New Mexico 87131. Tom Cummings, Director.
MESA/ Washington	Mathematics, Engineering and Science Achievement. College of Engineering, 353 Leow FH-10, Seattle, Washington 98195. Patricia MacGowan, Director.
METCON	District of Columbia Metropolitan Consortium for Minorities in Engineering. School of Engineering, Howard University, Washington, D.C. 20059. Elbert Cox, Executive Director.
PRIME	Philadelphia Regional Introduction for Minorities to Engineering. 1831 Chestnut Street, 6th Floor, Philadelphia, Pennsylvania 19103. Dr. Alexander Tobin, Executive Director.
PRIS²M	Program for Rochester to Interest Students in Science and Math. Industrial Management Council, 12 Mortimer Street, Rochester, New York 14604. Constance M. Mitchell, Program Director.
SECME	Southeastern Consortium for Minorities in Engineering. Georgia Institute of Technology, Room 208, Savant Building, Atlanta, Georgia 30332. Carolyn Chesnutt, Executive Director.
TAME	Texas Alliance for Minorities in Engineering. College of Engineering, University of Texas at Arlington, Arlington, Texas 76019. John S. Robottom, Executive Director.
UCMEP	Union County College Minorities in Engineering Program. Union County College, Springfield Avenue, Cranford, New Jersey 07016. Robert Blount, Coordinator.

APPENDIX C

Selected Bibliography

Note: These entries are arranged by date of publication in order to preserve a sense of the evolution of precollege science and mathematics programming for minority students.

Proceedings of the Symposium on Increasing Minority Participation in Engineering. Commission on Education, National Academy of Engineering. May, 1973.

This symposium was the first large-scale effort to delineate the problems of minority engineering participation and to frame potential solutions. The three-day gathering was attended by more than 250 participants from universities, professional societies, foundations, industry and government.

Minorities in Engineering: A Blueprint for Action. The Alfred P. Sloan Foundation. 1974.

Provides a comprehensive overview of the process by which engineering students are educated. The book sets out specific educational goals and measures of progress, suggests mechanisms for achieving those goals, estimates the financial cost and identifies possible sources of support.

Minorities in Engineering: The Chatham Summer Study on Pre-Engineering Education. Alfred P. Sloan Foundation. June, 1975.

The first major document to detail the need for activity at the precollege level if substantial numbers of minority students were to be prepared for engineering careers.

Building Effective Minority Programs in Engineering Education. National Academy of Sciences. September, 1975.

A summary of effective minority engineering program elements at both the precollege and college levels.

Proceeding of the National Workshop on Precollege Minority Engineering Efforts. Philadelphia Regional Introduction for Minorities to Engineering, Inc. October, 1977.

This three-day workshop brought together more than 300 participants representing industry, government, engineering schools and high schools. Individual sessions covered seven different aspects of precollege

programming including funding, industry involvement and innovative approaches.

Building the Multiplier Effort. National Academy of Sciences. 1979.

Summary of a September, 1978 symposium that brought together leaders of the minorities in engineering effort five years after the original 1973 symposium. The result of the 1978 meetings was a major push to expand and strengthen the program and the emphasis toward the precollege years.

Science and Engineering Education for the 1980's & Beyond. The National Science Foundation and the Department of Education. October, 1980.

An analysis of the needs of science and technology education at the precollege, college and graduate levels.

A Handbook and Resource Guide for Teachers, Industry Personnel and Program Managers. Philadelphia Regional Introduction for Minorities to Engineering, Inc. 1981.

An 80-page, step-by-step guide to the organization and implementation of a community-based precollege science and mathematics program.

Helping People Grow. Southeastern Consortium for Minorities in Engineering. February, 1982.

A 42 page manual for secondary school counselors and administrators compiled from ideas, suggestions and recommendations of high school counselors, administrators and engineering college representatives.

A "how to" manual designed to help prepare students for engineering and other mathematics-science based fields.

I Speak Basic to My TRS-80. Aubrey B. Jones, Jr. Hayden Book Co. (N.J.) 1982.

This is a textbook for a high school computer course which was developed by PRIME in Philadelphia and is now used by more than 150 schools across the country. Versions for Apple and Commodore are also available.

Educating Americans for the 21st Century. The National Science Board Commission on Pre-College Education in Mathematics, Science and Technology. 1983.

A proposal for sweeping change in the way precollege

mathematics and science education is carried out, including the need to involve many more students and to improve what is taught and learned.

The High School Study. Ernest L. Boyer. Carnegie Foundation for the Improvement of Teaching. 1983.

Proposes an urgent 12 point comprehensive school improvement program, including significant expansion of guidance services and the strengthening of connections between schools and colleges and between schools and industry.

A Nation at Risk: The Imperative of Educational Reform. The National Commission on Excellence in Education. 1983.

An assessment of the quality of teaching and learning in schools, colleges and universities and a definition of the problems which exist. One major recommendation is that three years of math and three years of science (including applications to everyday life) be made a requirement to earn a high school diploma.

Design for Excellence: How to Study Smartly. Lloyd M. Cooke. National Action Council for Minorities in Engineering, Inc. 1984.

This booklet, intended for the advanced secondary and beginning college student, outlines methods for improving study skills by organizing the material, focussing on what is yet unlearned and avoiding fruitless effort.

Leadership Training Manual. Southeastern Consortium for Minorities in Engineering. 1984.

In-depth guide for precollege program leadership. Designed for use in a workshop setting, the manual identifies and explains functions of SECME leaders: university and industry consultants, school system program directors and school coordinators.

Pre-College Program Directory. National Action Council for Minorities in Engineering, Inc. Annual Publication.

The 1984 edition provides basic information about more than 100 precollege minority programs which address the problem of increasing the number of minority secondary students prepared to study engineering and other technical university curricula. Appendices provide useful statistical information about national participation.

Robert A. Finnell, president of NACME, Mary Garcia, Walter F. Williams, president of Bethlehem Steel at NACME Forum '83 held in Chicago on June 7th. Mary was designated a member of NACME's first "All-American" team for excellence in engineering.

Eight future engineering students were awarded merit prizes named for former chairmen of the National Action Council for Minorities in Engineering at Forum '83 in Chicago on June 7.

NACME's "All-American" student team for excellence in engineering (l to r): Norris Kirby, Louisville, KY; Virginia Perdew, Atlanta, GA; Chris Gregory, Wilmington, DE; Regina Nelson, Holbrook, AZ; Craig Gregory, Wilmington, DE; Lourdes Rivera, Colorado Springs, CO; Collin Gregory, Wilmington, DE; Mary Garcia, New York City.

Former NACME chairmen (back row, l to r): Edson W. Spencer, chairman of Honeywell; John R. Opel, IBM chairman ; Edward R. Kane, former chairman of DuPont; Howard C. Kauffmann, president of Exxon.

APPENDIX D

Sponsors of NAPD PROGRAMS

Abbott Laboratories Inc.
Accelerated Schools
Activision, Inc.
Adolph Coors Company
Advanced Technologies, Inc.
Aerojet—General Tire
Aerospace Corporation
Alabama Power Company
Alcoa Foundation
Alfred P. Sloan Foundation
All American Engineering Company
Allied Chemical Corporation
Allied Corporation
Amdahl Corporation
American Cyanamid Company
American Indian Science & Engineering Society
American Hoechst Corporation Film Division
American Natural Resources Company
American Nuclear Society
American Society of Civil Engineers (Louisiana Section)
American Steel Company
Ametek, Inc.
Amex Systems
Amoco Chemicals Corporation
Amoco Foundation, Inc.
Amoco Production Company
Ampex Corporation
Anaconda Minerals
Analog Devices
Apple Computers
Applied Materials
Applied Technology
Archdiocese of Denver
Arco Chemical Company
Armstrong Data Services
Arthur D. Little Foundation
Association of Women Geoscientists
AT & T Communications
Atlanta Gas Light
Atlantic Richfield Company
Atlantic Richfield Foundation
Avon Products Inc.

Baker International
Bank of America
Bank of Boston
Barber-Colman Company
Barry Controls Inc.
Bechtel Companies
Bechtel Power Corporation
Beckman Instruments
Bell Helicopter—Textron
Bell of Pennsylvania
Bell Telephone Laboratories
Bendix Corporation
Bethlehem Steel Corporation
Black United Fund
Boeing Vertol Company
Boettcher Foundation
Boston Edison Company
Boston Gas Company
BP Oil Corporation
Bristol-Myers Company
Burk & Associates Inc.
Burroughs Corporation

Campbell Soup Fund
Carborundum Corporation
Carter-Wallace Inc.
Celanese Chemical Company Inc.
Celanese Corporation
Celanese Research Company
Central Power & Light Company
Champion International Corporation
Charles T. Main Inc.

Chesapeake & Potomac Telephone Company
Chevron Corporation
Chicago Bridge & Iron Company
Chime
CH2M Hill Inc.
Chrysler Corporation
CNG Producing Company
Codex Inc.
Colorado Association of Black Professional Engineers & Scientists
Colorado Fuel & Iron Company
Colorado Society of Hispanic Engineers & Scientists
Colt Industries
Columbia LNG Corporation
Computer Science Corporation
Conoco Incorporated
Consolidated Edison Company of New York, Inc.
Continental Forest Ind.
Convergent Technologies
Crown Zellerbach

David Taylor Naval Ship Research & Development Center
Davol Inc.
Delmarva Power & Light Company
B. Demster
Dennison Manufacturing Company
Denver Foundation
Detroit Edison
De Vlieg Foundation
Diamond Shamrock Corporation
Diamond State Telephone Company
Digital Equipment Corporation
Dolfinger-McMahon Foundation
Dow Chemical Company
Dow Chemical U.S.A.
Dow Corning Corporation
Dresser Industries Inc.
Dysan Corporation
E.I. duPont de Nemours & Company

Eastman Kodak Company
Ebasco Services Inc.
EG & G Inc.
Eli Lilly and Company
Endevco
L.M. Ericsson Telephone Company
ESL Inc.
Espy, Houston and Associates
EST Foundation
Executive Tower Inn
Exxon Company U.S.A.
Exxon Corporation
Exxon Education Foundation
Exxon U.S.A. Foundation

Federal Aviation Administration
Fisher-Price Toys
Fleet National Bank
Fluor Corporation
Fort Aerospace and Communications
FMC Corporation
FMC Corporation—Industrial Packaging Division
Ford Aerospace & Communications Corporation
Ford Motor Company
Ford Motor Company Fund
Formosa Plastics
Freeport Sulphur Company

Garrett Corporation
Gen Rad Foundation
General Dynamics Corporation
General Electric Carboloy
General Electric Company
General Electric Company—Medical Systems Division

General Electric Foundation
General Motors Corporation
General Motors Corporation—A.C. Sparkplug Division
General Motors Corporation—Chevrolet Division
General Motors Corporation—Harrison Radiator Division
General Telephone
Getty Oil Company
Getty Refining & Marketing Company
George Hyman Construction Company
Georgia Power Company
Georgia-Pacific Corporation
Gilbert Associates
Gillette Company
Goddard
Golden State Minority Fund
Gould Electronics
W.R. Grace Company
Graphic Controls Corporation
GSPE (Atlanta Chapter)
GTE Foundation
Gulf Oil Corporation
Gulf Oil Foundation

Harrington, George Dunn
Harry Diamond Laboratories—U.S. Army Electronics Research & Development CMD
W.R. Hearst Foundation
Hercules Inc.
Herric Foundation
Hewlett Foundation
Hewlett-Packard Company
Home Savings & Loan
Honeywell Foundation
Honeywell Inc.
Hospital Trust
Howard, Needles, Tammen and Bergendorff Inc.
Hughes Aircraft Company
Hunt-Wesson Foods Inc.
Husky Oil Company
Hydril Company

IBM Corporation
ICI Americas Inc.
IEEE (Atlanta Section)
Impell Corporation
Inmos Corporation
Input/Output Computer Services
Intel Corporation
Intel Systems Incorporated
International Paper Company Foundation
Intersil, Inc.
Irvine Company
Itek Optical Systems Company

Jets Inc.
John Hancock Life Insurance Company
Johnson Controls Foundation
Joseph Chavez & Company

Kaiser Aluminum & Chemical Corp.
Kendall Company
Kimberly-Clark Corporation
Koppers Company Foundation

Latin American Education Foundation
Law Engineering Testing
League of United Latin American Citizens
Litton Guidance and Controls
Lluela M. Murphy Foundation
Lockheed Leadership Fund
Lower Colorado River Authority

Magnavox
Marathon Petroleum Company
Martin Marietta Corp.–Aerospace
Martin Marietta Corporation
Mary H. Stuart Foundation
Mason & Hanger

McDermott Corporation
McDonalds—Detroit Black Owners Association
McNeil Consumer Products
McNeil Pharmaceutical
Merck Company Foundation
Merck Education Foundation
Merck Sharp & Dohme
Metropolitan Atlanta Foundation
Michigan Consolidated Gas Company
Milwaukee Foundation
Mitre Corporation
Mobil Oil Corporation
Mobil Foundation, Inc.
Monsanto Company
Monsanto Fund
Monsanto Industrial Chemical Company
Moore Business Forms
Moore Research
Motorola Inc.
Mountain Bell Telephone

Narragansett Electric Co.
National Aeronautics & Space Administration/Goddard Space Flight Center
National Aeronautics & Space Administration/Langley Research Center
National Aeronautics & Space Administration/Marshall Flight Center
National Bureau of Standards
National Fuel Gas
National Oceanographic & Atmospheric Administration
Natomas Company
Naval Surface Weapons Center
NCR Corporation
New England Electric Systems
New England Telephone
New Jersey Bell Telephone
New York Telephone Company
Niagara Mohawk Power
Nissan Design International
NL Industries
Norfolk Southern Corporation
Northrop Corporation

Occidental Chemical Corp.
Olin Corporation
Omega Psi Phi Fraternity
Outlet Company

Pacific Bell
Pacific Gas & Electric Co.
Pacific Northwest Bell Tel.
Parker Hannifin Corporation
Pennwalt Corporation
Petro-Lewis Oil Company
The Pfizer Foundation, Inc.
Philadelphia Electric Co.
Philadelphia Gas Works
Phillips Petroleum Company
Phoenix Steel Corporation
Polaroid Foundation
Potomac Electric Power Co.
PQ Corporation
D.W. Price Vacuum Truck Service Inc.
Prime Computer, Inc.
Printronix Inc.
Procter & Gamble Company
Public Service Company of Colorado
Public Service Company of New Mexico
Public Service Electric & Gas (New Jersey)

Radian Inc.
Raytheon Company
RCA Corporation
Rockwell Hanford
Rockwell International Corporation
Rohm and Haas Company
Rolm Corporation

Sandia National Laboratory
San Diego Gas & Electric Company

San Diego Trust
Schlumberger Offshore Service
Scientific Atlanta
Scott Aviation
Scott Paper Company
Security Pacific Foundation
Security Pacific National Bank
Shell Companies Foundation Inc.
Shell Oil Company
Siecor
Siemens-Allis, Inc.
Sierra Research Corporation
SKF Industries
Society of Women Engineers
South Central Bell Telephone
Southern Bell
Southern Bell—Georgia
Southern California Edison Company
Southern California Gas Company
Southern Education Foundation
Southwestern Bell Telephone Co.
Sperry Corporation
Standard Oil Company (Ohio)
Stauffer Chemical Company
Stearns Catalytic Corporation
Stearns-Roger Engineering Corp.
Stone & Webster Engineering Corp.
Stroh Brewery Corporation
Sun Companies
Sun Petroleum Products Company
Sun Refining & Marketing Company
Sunolin Chemical Company
Sverdrup/Parcel
Syntex Corporation

Teledyne Inc.
Teledyne Water Pik
Tenneco Inc.
Tenneco Oil Company P. & M.
Tenneco Oil Exploration & Production Company
Tennessee Valley Authority
Teradyne Inc.
Texaco Inc.
Texaco U.S.A.
Texas Eastern Foundation
Texas Instruments Inc.
Textron Inc.
Tracor Inc.
TRW Foundation
TRW Inc.
TRW Systems
Turner Construction Company

Union Camp Corporation
Union Carbide Corporation
Union Oil Company
Union Pacific Foundation
United Bank of Denver
United Engineers & Constructors Inc.
United Gas Company
United States Air Force
United States Air Force Academy
United States Army Corps of Engineers
United States Bureau of Reclamation
United States Department of Energy
United States Department of Transportation
United States Food & Drug Administration
United Technologies/ Pratt & Whitney
Unitrode Corporation

Verbatim Corporation
Vitro Laboratories
Vons Grocery Company

Waldemar S. Nelson & Company
Warner-Lambert Company
Washington Natural Gas Co.
Western Electric Company

Westinghouse Broadcasting Company
Westinghouse Educational Foundation
Westinghouse Electrical Corp.
Westwood Pharmaceuticals Inc.
Weyerhaeuser Company
Whittaker Corporation
The William Penn Foundation
Williams, Russell, and Johnson, Inc.
Wisconsin Gas Company
Wisconsin Electric Power Company
Wisconsin Bell Inc.
Woodward Governor Company
Wyle Laboratories
Wyman-Gordon Company
Wyman-Gordon Foundation

Xerox Corporation